

THE OHIO JOURNAL OF SCIENCE

VOL. XLVI

MAY, 1946

No. 3

THE FERNS OF BURMA¹

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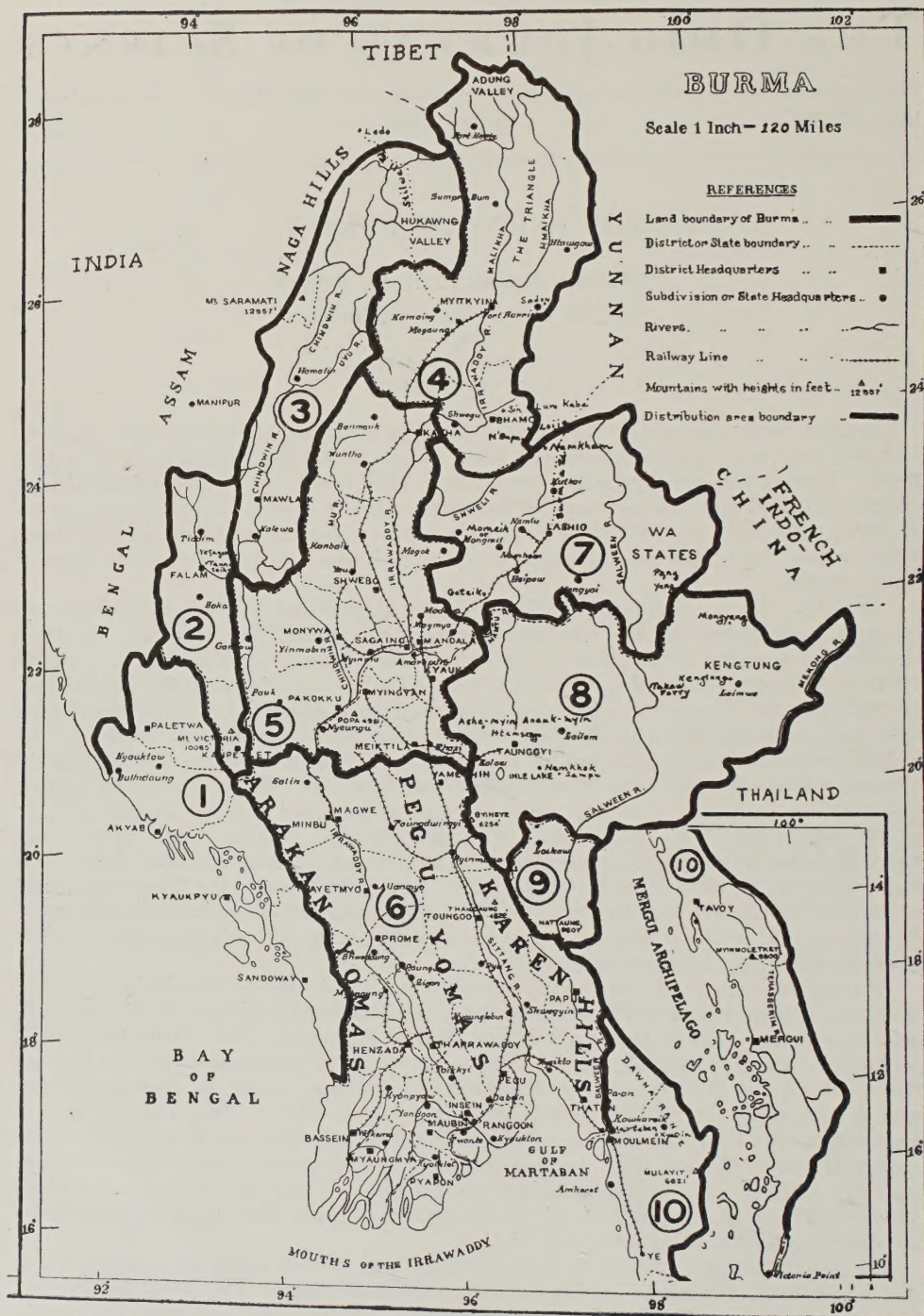
Burma, with rainfalls in its various districts of 20 to 225 inches from June to October and with habitats from sea level up to 18,000 feet, has a very rich fern flora. During the hundred years previous to 1920 fern study was confined almost entirely to the Pegu and Tenasserim Districts of lower Burma, but with the Joseph H. Rock collection of 1920-1924 from upper Burma, western China, and northern Siam, came the first accurate concept of the richness and variety of the ferns of upper Burma.

In 1931 the C. Snydam Cutting Sikkim Expedition of the Field Museum brought back about 25 fern specimens from the Burma-Tibet frontier. In 1937 the Vernay-Cutting Expedition of the New York Botanic Garden and the Natural History Museum collected in upper Burma and added two ferns to the Burma list. In 1943 Harold Young collected over a hundred ferns along the Stilwell Road near the Assam-Burma border, of which twenty were new records for Burma. The writer named the ferns collected by the Cutting Sikkim Expedition and by Harold Young. From 1930 to 1942 the writer has collected over 325 kinds of ferns in various parts of Burma. The total number of ferns reported to date for the country is 460, which belong to 104 genera. The writer's main collection is in the Herbarium of Judson College, Rangoon, Burma; duplicates of some numbers have been distributed to Gordon College, Rawalpindi, India, to Ohio State University, and to the Arnold Arboretum under whose auspices a part of the collecting was done. Numbers cited in the following enumeration refer to the writer's specimens, unless another collector's name is given.

Burma is so located that many ferns of both the China-Himalayan and the Malayan regions occur in the country. Of the 460 ferns reported for Burma, 125 are to be found also in that part of the Malay Peninsula which is under British protection, south of latitude 6.5° N. This is particularly remarkable because Burma lies north of the area having both summer and winter rains; in Burma the dry season lasts from the middle of October to the end of May. This long dry period must effectively limit the northward migration and establishment of many Malayan species whose ecological amplitude is not sufficient to permit them to survive the long dry season. An unpublished list of the ferns of the Malay Peninsula compiled in 1937 by R. E. Holttum of the Singapore Botanic Garden reports 419 ferns as occurring south of latitude 6.5° N.

Of the 125 ferns common to both Malaya and Burma some are cosmopolitan species such as *Adiantum capillus-veneris*, *Osmunda regalis*, *Pteridium aquilinum*, and *Pteris vittata*. Others are pantropic such as *Asplenium cuneatum*, *Didymochlaena truncatula*, *Dryopteris paleacea*, *Elaphoglossum petiolatum*, *Histiopteris incisa*,

¹Papers from the Department of Botany, The Ohio State University, No. 491.



Map of Burma showing areas referred to in the text: 1, Arakan; 2, Chin Hills; 3, Upper Chindwin; 4, North-east Burma; 5, Central Burma; 6, Southern Burma; 7, Northern Shan States; 8, Southern Shan States; 9, Karenni, 10, Tenasserim.

Mecodium polyanthos, *Mephrolepis biserrata*, *N. cordifolia*, *N. exaltata* (*falcata*), *Pityrogramma calomelanos*, *Pteris biaurita*, and *Pteris quadriaurita*. There are rather more species common to Burma and Malaya which may also be found in Madagascar and (or) South Africa (Christensen 1932): this group includes *Adiantum caudatum*, *A. philippense*, *Asplenium adiantoides*, *A. macrophyllum*, *A. normale*, *A. unilaterale*, *Ceratopteris thalictroides*, *Crepidomanes bipunctatum*, *Davallia denticulata*, *Dicranopteris linearis*, *Lindcaya cultrata*, *Microsorium punctatum*, *Ophioglossum pedunculatum*, *O. pendulum*, *Schizoloma ensifolia*, *Stenoloma chusanum*, *Thamnopteris nidus*, and *Vittaria scolopendrina*.

The following genera which have representatives in the Burma flora are absent from Holttum's list of peninsular species: *Arthromeris*, *Azolla*, *Botrychium*, *Colysis*, *Cryptogramma*, *Ctenitis*, *Cyclopettis*, *Cyrtomium*, *Davallodes*, *Diplaziosis*, *Goniopteris*, *Lemmaphyllum*, *Marsilea*, *Microchlaena*, *Monachosorum*, *Neocheiropteris*, *Onychium*, *Salvinia*, *Selliguea*, and *Woodwardia*. In addition to these genera the Burma flora is much richer than the Malayan in *Cheilanthes*, *Dryopteris* sensu propria, *Lepisorus*, *Phymatodes*, *Polypodium* sensu propria, and *Polystichum*. The above 26 genera together with many others are widely distributed from northern India across Burma to southwestern and central China. The frequency of this distribution is emphasized by Ching's revisions of the genera "Dryopteris" and "Polypodium" of the China and Sikkim-Himalayan areas (1933b, 1933c, 1933d, 1934b, 1935c, 1936b, 1936c, 1938a, 1938b, 1938c, 1941c). These studies indicate essential similarity of the fern flora throughout the eastern Himalayas, Burma, and southwestern and central China. Since Burma is situated at the northwestern end of the Malaya Peninsula, and at the junction of the east-west ranges of the Indian Himalayas and the north-south ranges of Tibet and western China, the Burma fern flora is composed of species of these vast areas. Present records indicate that the northern species predominate over the southern species about 3 to 1.

KEY TO THE GENERA OF THE FERNS OF BURMA

1. Aquatic ferns.....2
1. Not water ferns.....5
 2. Leaflets 4, clover-like.....102. **Marsilea**
 2. Leaf blade not like a 4-leaf clover.....3
3. Leaves relatively large (6–18 in.), pinnatifid or compound; vegetative budding from the leaflet axils or sinuses; rooted or free floating.....101. **Ceratopteris**
3. Leaves either minute or up to an inch long, entire, leaf margins not budding; free floating..4
 4. Leaves in whorls of 3, the upper 2 very hairy and floating, the third submerged and root-like.....103. **Salvinia**
 4. With very minute leaves closely placed on a branched stem, only slightly hairy; no dissected root-like leaf.....104. **Azolla**
5. Leaves simple, margin entire or nearly so.....6
5. Leaves simple but dichotomously forked or palmately lobed.....29
5. Leaves pinnatifid or compound.....31
 6. Sporangia on narrow spike-like sporangiophores arising from the base or apex of the sterile part of blade.....7
 6. Sporangia not as above.....9
7. Sporangiphore arising from the base of the sterile part of blade; no annulus on the sporangia.....1. **Ophioglossum**
7. Sporangiphores arising from the apex of the sterile part of blade.....8
 8. Sterile part of blade grass-like; sporangia in digitate or pinnate tassels; annulus around the pointed apex of the large sporangia.....6. **Schizaea**
 8. Sterile part of blade not grass-like; sporangia small, on the very much narrowed, prolonged apex of the leaf; sporangia polypodioid.....49. **Hymenolepis**

9. Sporangia not in sori but covering back of blade, or so close together that they do not appear to be in sori. 10
9. Sporangia in marginal or linear sori, or following reticulate veins. 12
9. Sori round or roundish, sometimes very close together and almost hidden by stellate hairs, 22
 10. Veins free, simple or forked. 64. *Elaphoglossum*
 10. Veins anastomosing or reticulate. 11
11. Fertile leaf narrowly linear and entirely fertile; no stellate hairs. 55. *Leptochilus*
11. Sporophylls usually not contracted; stellate hairs abundant, almost hiding sori, 59. *Pyrrosia*
 12. Sori linear, parallel to margin (intramarginal) or marginal. 13
 12. Sporangia forming a network along reticulate veins. 16
 12. Sori oblique to the midrib. 17
13. Leaves dimorphic. 14
13. Leaves uniform. 15
 14. Epiphytic, sporophylls linear. 60. *Drymoglossum*
 14. Terrestrial, sporophylls deeply lobed and long petioled. 90. *Doryopteris*
15. Linear sorus sunk in a groove at or near margin; blade grass-like. 63. *Vittaria*
15. Linear sorus 1-2 mm. inward from each margin, not sunk in grooves. 48. *Lepisorus* (part)
 16. Petiole of fertile leaf much elongated, polished. 99. *Hemionitis*
 16. Petiole of fertile leaf like that of sterile, not elongated. 62. *Antrophyum*
17. Indusium present. 18
17. Indusium lacking. 20
 18. Veins free. 19
 18. Veins united by a marginal vein. 37. *Thamnopteris*
19. Sori in opposite pairs on adjacent veins, their indusia opening toward each other, often finally confluent. 36. *Phyllitis*
19. Sori not normally twinned in opposite pairs, single. 38. *Asplenium*
 20. Without (or with very few) included veinlets. 61. *Loxogramme*
 20. Free included veinlets present in the areoles. 21
21. Leaves herbaceous; lateral main veins flexuous and poorly developed; rhizome subhypogaeous. 54. *Colysis*
21. Leaves thick, rigid, glossy; lateral veins strong, raised, straight, reaching the margin; rhizome epigaeous, creeping. 52. *Selliguea*
 22. Sori not on the end of veins or at the margin; blade more than 1 cell thick. 23
 22. Sori on the end of veins or at the margin in cup or tubelike cavities; blade 1 to few cells thick. 70. *Microgonium*
23. Sori in 1 row (rarely 2) between the midrib and margin. 24
23. Sori in several rows between the main lateral veins or irregular; sometimes uniseriate in *Neocheiropteris ensata*. 27
 24. Indusium present; venation free, forked. 40. *Oleandra*
 24. Indusium lacking; venation not free. 25
25. Rhizome thick, fleshy, creeping; blades coriaceous, usually pinnatifid; venation drynarioid or goniophleboid, main laterals distinct. 51. *Phymatodes*
25. Rhizome creeping but not very fleshy; blades usually simple. 26
 26. Rhizome slender, wide-creeping, subnaked; leaves distant, glabrous, fleshy, usually dimorphic. 50. *Lemmaphyllum*
 26. Rhizome usually short creeping, very scaly; leaves fairly close, coriaceous or papery, generally uniform. 48. *Lepisorus*
27. Leaves bearing stellate hairs; sori close together, sometimes almost hidden by the stellate hairs. 59. *Pyrrosia*
27. Leaves without stellate hairs; sori distant. 28
 28. Rhizome hypogaeous, thick, fleshy, densely scaly with a tuft of unicellular brown hairs at point of attachment; sori covered when young with large, fuscous, clathrate, peltate scales. 47. *Neocheiropteris*
 28. Rhizome wide-creeping or scandent; no tuft of unicellular brown hairs at point of attachment of rhizome scales; clathrate, peltate scales in sori usually lacking, 53. *Microsorium*

29. Leaf blade $\frac{1}{2}$ in. each way, thinly membranous..... **Gonocormus**
 29. Leaf blade much larger, much thicker texture.....30
 30. Epiphyte; leaf large, often dichotomously branched; sporangia crowded on soriferous disc..... **44. Platycerium**
 30. Terrestrial fern, palmately lobed; sori in a continuous marginal line..... **90. Doryopteris**

LEAVES PINNATIFID OR COMPOUND

31. Sori surficial.....32
 31. Sori marginal, or in spike-like, panicle-like, or strobilus-like arrangement.....33
 32. Sporangia spread over part of all the surface, not in sori (acrostichoid).....34
 32. Sporangia in definite elongate sori.....40
 32. Sporangia in round or roundish sori.....53
 33. Sporangia in marginal sori.....82
 33. Sporangia in spike-like, panicle-like, or strobilus-like arrangement.....101
 34. Sporangia on apical pinnae, other pinnae sterile..... **100. Acrostichum**
 34. Sporangia on partially or wholly fertile leaves; other leaves sterile.....35
 35. Scandent fern, margin of leaflets cartilagenous, pinnae articulate with the rachis; veins parallel..... **24. Stenochlaena**
 35. Scandent, margins not cartilagenous; veins reticulate..... **25. Lomagramma**
 35. Not scandent, terrestrial, exindusiate.....36
 36. Leaves bipinnate with white powdery coating on the under surface, **98. Pityrogramma**
 36. Leaves pinnate or pinnatifid, without powdery coating.....37
 37. Rhizome erect or suberect, sometimes several feet tall.....38
 37. Rhizome creeping, usually short.....39
 38. Base of petioles covered with scales 1 in. long; base of pinnae cordate; caudex several inches thick..... **43. Brainea**
 38. Base of petioles enlarged and flat on adaxial face; base of pinnae not cordate, no long scales..... **85. Plagiogyria**
 39. Veins free..... **21. Egenolfia**
 39. Veins anastomosing..... **23. Bolbitis**

SPORANGIA IN DEFINITE ELONGATE SORI ON ABAXIAL SURFACE

40. Sori apparently parallel to the midribs and margins.....41
 40. Sori oblique to the midribs.....47
 41. Venation free.....42
 41. Venation reticulate.....45
 42. Leaf palmately compound (dichotomously divided)..... **Actiniopteris**
 42. Leaf pinnatifid or pinnate.....43
 43. 3- or 4-pinnatifid, fertile segments narrow, podlike, sori covering most of segment at maturity.....44
 43. Pinnate or pinnatifid; sorus contiguous to midrib, not near the margin..... **41. Blechnum**
 44. Vascular commissure connecting vein ends; leaves more than 5 in. long..... **91. Omychium**
 44. Without commissure; leaves usually less than 5 in. long..... **88. Cryptogramma**
 45. Fertile segments narrow; reflexed leaf margins meeting at the midrib; aquatic fern, **101. Ceratopteris**
 45. Fertile pinnae not narrowed; sori not covering the whole blade; not aquatic ferns.....46
 46. Sori short, linear, contiguous with midribs; indusium present..... **42. Woodwardia**
 46. Sori the length of the pinnae, half way between midrib and margin..... **96. Taenitis**
 47. Without indusium.....48
 47. Usually with indusium.....50
 48. Veins anastomosing with free included veinlets..... **54. Colysis**
 48. Veins parallel and very close, branching once or twice.....49
 49. Sori following the veins from midrib nearly to margin; distinct hydathodes near margin, **97. Congiogramme**

49. Sori following veins with sporangia in 2 rows, near the margin but not extending to midrib; sori make line parallel with margin; huge fern; stipules fleshy. 4. **Angiopteris**
50. Sori all simple, never curved across a vein; lumen in cells of scales hyaline (clear), ... 38. **Asplenium**
50. Sori sometimes bent across a vein; delicate ferns; lumen in cells of scales pigmented, ... 32. **Athyrium**
50. Sori sometimes double; coarse ferns; lumen in cells of scales pigmented. 51
51. Veins anastomosing. 35. **Diplaziopsis**
51. Veins free. 34. **Diplazium**

SPORANGIA IN ROUND OR ROUNDISH SORI ON ABAXIAL SURFACE

53. Tree ferns. 54
53. Not tree ferns. 55
54. With costal areoles and free excurrent veins. 43. **Brainea**
54. Without costal areoles. 10. **Cyathea**
55. Rachis of leaves dichotomously branched, often a dormant bud in axil or branching; annulus transverse; sporangia sessile. 56
55. Not dichotomously branched; annulus neither transverse nor oblique; sporangia not sessile. 57
56. Leaves 1-pinnate (pectinate) above highest fork. Rhizome slender, hairy; blade of indefinite growth with pair of stipule-like pinnae at the forkings; veins 3-6 forked in each group; 6-12 sporangia per sorus. 8. **Dicranopteris**
56. Leaves bipinnate above last fork. Rhizome often $\frac{1}{2}$ in. thick, densely scaly, blade of definite growth, no stipule-like pinnae at the sides of the forking; veins once forked; 2-6 sporangia per sorus. 9. **Hicriopteris**
57. Indusium lacking or quickly fugaceous. 58
57. Indusium present, persistent. 68
58. Leaves pinnatifid or pinnate. 59
58. Leaves slightly bipinnatifid to decompound. 64
59. Veins free and forked, or anastomosing to form 1 row (rarely 2) of subhexagonal costal areolae each with a simple excurrent soriferous veinlet. 46. **Polypodium**
59. Veins copiously reticulate forming many rows of small areoles with included veinlets. 60
59. Veins anastomosing by opposite pairs. 67
60. Some vegetative leaves wholly modified and humus collecting. 58. **Drynaria**
60. No vegetative leaves entirely modified nor humus collecting. 61
61. Very large leaves (± 3 ft. long) with base of the petioles expanded and humus collecting (no distinct petiole). 57. **Pseudodrynaria**
61. Leaves with distinct petioles, or sessile, but base not modified and humus collecting. 62
62. Blade generally pinnate (juvenile forms simple) with articulated pinnae, ... 56. **Arthromeris**
62. Blade simple, pinnatifid (rarely pinnate but if so, pinnae not articulate to rachis). 63
63. Leaf generally coriaceous, simple or pinnatifid with principal nerves reticulate, distinct; often dimorphous, sori in 1-2 rows between main veins; plant glabrous. 51. **Phymatodes**
63. Leaf generally thin, entire (rarely pinnatifid), uniform, without distinct principal nerves; sori small, scattered irregularly, round, rarely in 7-8 regular rows. 53. **Microsorium**
64. One vein in each ultimate leaf segment. 86. **Monachosorum**
64. More than 1 vein in each ultimate leaf segment. 65
65. Veins usually reticulate or anastomosing. 67
65. Veins free or with costal arch. 66
66. Habit of finely divided *Pteridium aquilinum*; leaf hairy on both surfaces; no tooth in sinuses. 49. **Hypolepis**
66. Habit of *Pteris quadriaurita*; a tooth in each sinus. 19. **Pteridrys**
67. Free included veinlets present. 22. **Tectaria**

67. Without free included veinlets.....105
 68. Indusium inferior, globose, entire.....11. *Diacalpe*
 68. Indusium peltate, reniform, or half cup-shaped.....69
 69. Veins anastomosing or reticulate.....70
 69. Veins free.....72
 70. Without free included veinlets.....105
 70. With free included veinlets.....71
 71. Small irregular areoles, included veinlets pointing in all directions.....22. *Tectaria*
 71. Larger subhexagonal areoles formed by repeated dichotomous branching of the veins;
 free included veinlets pointed in one direction only; sori in 1 or 2 lines, parallel with
 the midrib.....17. *Cyrtomium*
 72. Terrestrial (or if epiphytic, then pinnae articulate to rachis).....73
 72. Epiphytic.....79
 73. Pinnae or pinnules articulate to the rachis.....74
 73. Pinnae not articulate to the rachis.....75
 74. Indusium oblong, attached longitudinally; leaf bipinnate.....84. *Didymochlaena*
 74. Indusium reniform; leaf pinnate.....83. *Nephrolepis*
 75. Indusium suborbicular or scale-like, inserted under the base of sorus; long, weak, jointed
 hairs on costa, rachis and pinnules; veins reaching the margin.....33. *Cystopteris*
 75. Indusium reniform.....76
 75. Indusium peltate.....77
 75. Indusium fixed by base and sides.....78
 76. Davallioid ferns, leaf pinnately decompound, pinnules in general rhomboidal in out-
 line; rhizome creeping.....80. *Leucostegia*
 76. Dryopteroid ferns, leaves not with decompound ultimate rhomboidal segments...112
 77. Sori in 1-3 rows on each side of midrib and parallel to it; petiole fibrillose at the base;
 pinnae nearly entire, cordate or truncate at the base.....15. *Cyclopeltis*
 77. Sori in 1 row; pinnae enlarged on acroscopic side of the base, toothed; petiole scaly,
 14. *Polystichum*
 78. Stem erect; rachis nodose above at the insertion of pinnae; wide scales beneath at
 the base of each pinna; like *Cystopteris* but here veins do not reach the margin,
 79. *Acrophorus*
 78. Stem creeping.....*Microlepia*
 79. Leaves once pinnate, leaflets articulate to rachis.....83. *Nephrolepis*
 79. Leaves several times pinnate, leaflets not articulate to rachis.....80
 80. Leaves thin, pubescent, not deltoid; rhizome scales needle-pointed and mostly
 black.....78. *Davallodes*
 80. Leaves coriaceous or herbaceous, glabrous, often deltoid; rhizome scales not
 black, but brown or grey.....81
 81. Indusium thin, free except at the base.....80. *Leucostegia*
 81. Indusium broad, firm to coriaceous, attached by base only; rhizome scales not ciliate
 (or but slightly so).....81. *Humata*
 81. Indusium attached at sides and base; rhizome scales ciliate with peltate, persistent
 bases.....82. *Davallia*
 85. Walls of cells thick, coarsely pitted.....69. *Meringium*

SPORANGIA IN MARGINAL SORI: ROUND, CUP-SHAPED, CONTINUOUS OR INTERRUPTED

82. Leaves so thin that there is no differentiation of foliar tissues.....83
 82. Leaves thick enough to have epidermis and other tissues.....91
 83. Indusium valvate.....84
 83. Indusium tubular or obconic, not valvate.....87
 84. Margin entire and naked.....85
 84. Margin toothed.....86

85. Walls of cells not coarsely pitted.....68. *Mecodium*
 86. Receptacle long, extruded; base of indusium obconic.....69. *Meringium*
 86. Receptacle not long-exserted.....67. *Hymenophyllum*
 87. Rhizome filiform, leaves remote.....88
 87. Rhizome stout or fronds clustered.....90
 88. False veinlets present.....89
 88. False veinlets absent, segments 1-nerved.....71. *Vandenboschia*
 89. Fronds pinnately divided or compound.....66. *Crepidomanes*
 89. Fronds simple or lobed, with marginal vein.....70. *Microgonium*
 90. Fronds 1-pinnate, oriental.....64. *Cephalomanes*
 90. Fronds bipinnatifid to decompound.....71. *Vandenboschia*
 91. Indusium distinctly 2-valved, rhizome covered with long, red, hair-scales; very large fern.....72. *Cibotium*
 91. Indusium opening along or towards margin.....92
 91. Indusium or marginal flap opening away from margin.....95
 92. Sori usually continuous; leaf at most bipinnate.....93
 92. Sori more or less round; leaf more compound.....94
 93. Leaflets cut away on the lower side; veins free, forking.....75. *Lindsaya*
 93. Veins anastomosing.....76. *Schizoloma*
 94. Leaflets cuneate.....77. *Stenoloma*
 94. Leaflets not cuneate (look out for *Davallia* and *Asplenium* with sori dorsal but indusia reaching the margin).....75. *Dennstaedtia*
 95. Leaves seriate on a creeping rhizome.....96
 95. Leaves clustered.....98
 96. Veins anastomosing with costal areoles.....93. *Histiopteris*
 96. Veins free or with marginal vein.....97
 97. Sori round on tips of free veins.....87. *Hypolepis*
 97. Sori continuous, on marginal vein connecting free vein tips.....92. *Pteridium*
 98. Petioles dark, polished.....99
 98. Petioles not polished.....100
 99. Sori on the inside of the reflexed leaf margin; leaflets cut away on the lower side, no white powder on under surface.....95. *Adiantum*
 99. Sori on the tips of free veins, not on the reflexed margin; leaflets pinnatifid; usually white powder on under surface.....89. *Cheilanthes*
 100. Sori never reach the midrib; coarse ferns.....94. *Pteris*
 100. Sori apparently from margin to midrib; leaf very decompound.....91. *Onychium*

SPORANGIA IN SPIKE-LIKE, STROBILUS-LIKE, OR PANICLE-LIKE ARRANGEMENT

101. Climbing ferns, sporangia in strobilus-like marginal lobes or pinnae, with scale-like indusia covering each sporangium.....7. *Lygodium*
 101. Not climbing, sporangia not in marginal strobili.....102
 102. Veins reticulate, leaf simple, entire; sporangia in two rows in a narrow close spike; no annulus.....1. *Ophioglossum*
 102. Veins free, leaves not simple, or if simple, then grass-like.....103
 103. Sterile part of leaf palmately compound; long loose spike-like sporangiophore arising from the base of the sterile blade; sporangia in crested loose clusters, 3. *Helminthostachys*
 103. Sterile part of leaf grass-like, linear, or dichotomously branched; sporangia in 2-4 rows covering one side of close distichous spikes at apex of sterile blade.....6. *Schizaea*
 103. Sterile part of leaf pinnate to repeatedly pinnatifidly compound.....104
 104. The entirely fertile pinnae never long-stalked.....5. *Osmunda*
 104. The fertile pinnae always long-stalked sporangiophores.....2. *Botrychium*

GENERA SEPARATED FROM "DRYOPTERIS" AND "POLYSTICHUM" BY CHING AND CHRISTENSEN

105. Veins free (simple or forking, or with costal arch).....106
 105. Veins, at least the lowest, anastomosing by opposite pairs.....117
 106. Indusium fugaceous or lacking.....107
 106. Indusium present, persistent, obvious.....110
 107. Very long needle-like but septate pale brown hairs on all parts of leaves...27. *Lastreopsis*
 107. Hairs not septate, or if septate, then only on upper side and not on all parts of leaves...108
 108. Veins simple, rarely forked after leaving the midrib of ultimate lobes, 26. *Thelypteris*
 108. Veins forking in groups; the abaxial basal vein of each group comes from the costa
 of the pinna some distance below the midrib of the group (catadromous).....109
 109. Pinnae deeply pinnatifid, a tooth in each sinus.....19. *Pteridrys*
 109. Pinnae not deeply pinnatifid; no teeth in the sinuses; very brittle.....16. *Microchlaena*
 110. Margins prickly serrate; segments sharply auricled on the adaxial side of the base..111
 110. Margins not prickly serrate; segments not sharply auricled on adaxial side of base, 112
 111. Leaves decompose, rhizome creeping, leaves distant, not gemmiferous at or near apex;
 anadromous arrangement of lowest pinnules of I, II, III orders, and of basal vein of
 ultimate pinnules.....13. *Rumorha*
 111. Leaves pinnate to bipinnate, lanceolate to oblong; rhizome oblique or erect, leaves
 caespitose; often gemmiferous at or near apex.....14. *Polystichum*
 112. Prominent deltoid, acute, callous tooth at each sinus between the segments of the
 pinnae as in *Bolbitis*; habit of *Pteris quadriaurita*.....19. *Pteridrys*
 112. No callous tooth at the sinus.....113
 113. Sori on abaxial branch only of forking vein; habit of *Tectaria*.....20. *Ctenitopsis*
 113. Sori on unbranching lateral veins.....114
 114. Multicellular, articulated, crisped, brown hairs on costa, costules, and midribs
 intermixed with clathrate scales with clear lumina in cells; dry leaves dry-brown
 or red-brown.....18. *Ctenitis*
 114. No such articulated, crisped, brown hairs; cells of scales not with clear lumina; dry
 leaves usually pale green (except *D. sparsa* and *Hypodematium crenala*).....115
 115. Base of petiole swollen, covered with imbricating, bright, rufo-brown scales; no scales
 above base; blade densely pilose on both surfaces.....28. *Hypodematium*
 115. Base of petiole not swollen, scales not limited to base, or if so, meager.....116
 116. Indusium large, persistent, thick, round-reniform; rhizome erect or sometimes
 oblique, leaves caespitose; bases of costa and costules, and midribs decidedly
 decurrent; costa and costules deeply canaliculated above, with broken flexuous
 edges; stipe usually scaly; catadromous arrangement of lowest pinnules,
 12. *Dryopteris*
 116. Indusium lacking, or small and reniform; rhizome creeping, leaves distant; costa,
 costules, and midribs not decurrent; grooved above, but not broken into by
 the lateral branches; stipe scaly only near base.....26. *Thelypteris*
 117. Leaves pinnate or bipinnatifid with coadunate-pinnatifid apex; stellate or forked uni-
 cellular hairs absent; as a rule indusiate.....29. *Cyclosorus*
 117. Leaves simple or imparipinnate, with the *mature* apical pinna usually being similar to
 the laterals; stellate or forked unicellular hairs sometimes present on rhizome scales
 and rachis.....118
 118. Base of leaflets cordate; leaves often proliferous, scandent, and of indefinite
 growth; short stalked stellate or forked unicellular hairs present on rhizome
 scales and lower part of young rachis.....30. *Goniopteris*
 118. Base of leaflets wedge-shaped or decurrent; leaves not proliferous or of indefinite
 growth; stellate or forked unicellular hairs absent; indusia none or if present
 generally small, thin, often hirsute and as a rule fugaceous.....31. *Abacopteris*

AN ENUMERATION OF THE FERNS OF BURMA AND THEIR DISTRIBUTION²

OPHIOGLOSSACEAE

1. *Ophioglossum* L.

- O. pedunculatum* Desv. Mingaladon—L. P. Khanna. First record for Burma.
O. pendulum L. Tavoy, Hondraw River—Parish.

2. *Botrychium* Swartz

- B. lunaria* (L.) Sw. Adung Valley, Burma-Tibet frontier, 12,000 ft.—Ward 9986. First record for Burma.
B. lanuginosum Wall. Loimwe, Kengung State—520; Taunggyi—Maymyo Herb. 576.

3. *Helminthostachys* Kaulfuss

- H. zeylanica* (L.) Hk. Tenasserim—Parish; Kamorta—Kurz; Katha Distt.—Maymyo Herb. 73.

ANGIOPTERIDACEAE

4. *Angiopteris* Hoffm.

- A. caudatifolia* Hieron. Mogok—108; Kengtung Territory—Rock 2323.
A. crassipes Wall. Thandaung—6785. First record for Burma.
A. griffithsiana de Vriese. Mergui—Ind. Fil.
A. helferiana de Vriese. Taungwine, Moulmein—6865; Pyinmana—7134. First record for Burma.

OSMUNDACEAE

5. *Osmunda* L.

- O. javanica* Bl. In bed of streams from Mt. Nwalabo, Tavoy—Parish; Bantai, Kengtund State—9260.
O. cinnamomea L. Loimwe, Kengtung State—9104. First record for Burma.
O. japonica Thunbg. Sin Lum Kaba, Bhamo Distt.—385; Haka, Boinu River Valley, Chin Hills—7476. First records for Burma.

SCHIZAEACEAE

6. *Schizaea* Smith

- S. malaccana* Baker. Burma—Ind. Fil.

7. *Lygodium* Sw.

- L. scandens* (L.) Sw. Taungwine, Moulmein—6848; Namkham, N. S. S.—45, 219; Stilwell Rd.—Young.
L. polystachyum Wall. Madremacan, Mergui—Parish; Muang Len, Kengtung State—Rock 2017.
L. salicifolium Presl. Namkham, N. S. S.—230, 233, 239, 44; Kengtung—9180; Manhsum, Manglon State—9756; Mogok—115, 116, 117. First records for Burma.
L. flexuosum (L.) Sw. Mingaladon 615; Rangoon—43, 161, 168, 181, 467, 6533; Syriam—466; Moulmein—570, 576, 6846; Myawaddi to Kawkereik Hills, Lower Burma—Rock 678; Kengtung State—Rock 1975.
L. japonicum (Thbg.) SW. Namkham, N. S. S.—226, 231, 232, 234; N'Bapa—257, 258; Loimwe, Kengtung State—517; Mong Pawk, Kengtung State—9827; Kalaw—46; Mt. Popa—566; Taungwine, Moulmein—6846; Stilwell Rd.—Young 7.

²The nomenclature used in that of Christensen's Third Supplement to his Index Filicum (1936) unless otherwise stated under the individual genera. When the relationship of species is evident, this is indicated by their order in the enumeration; when the relationship is not evident, species are arranged alphabetically.

GLEICHENIACEAE

8. *Dicranopteris* Bernhadi

(Ching 1940c)

- D. linearis* (Burm.) Underw. Amherst and Mergui—Parish; Kalaw—14; Thandaung—14B; Namkham—14A; Mogok—3005; Sin Lum Kaba—335; Loimwe—533, 9129; Stilwell Rd.—Young 25.
- D. splendida* (Hand. & Mazz.) Ching. Thandaung—50; Loimwe—533. First records for Burma.

9. *Hicriopteris* Presl

(Ching 1940c)

- H. glauca* (Thbg.) Ching. Nattaung Mt.—Parish; Sin Lum Kaba—297, 322; Stilwell Rd.—Young 66.
- H. laevissima* (Christ) Ching. Sin Lum Kaba—283. First record for Burma.

CYATHEACEAE

10. *Cyathea* Smith

(Copeland 1909, Holttum 1935)

- C. brunoniana* (Wall.) Cl. & Bak. Between Sadon and the Yunnan border—Rock 7464.
- C. contaminans* (Wall.) Copel. Kengtung State—Rock 2097, 2087; Mogok—133A.
- C. decipiens* (Scott) Cl. & Bak. Mogok—133. First record for Burma.
- C. gigantea* (Wall.) var. or sp. nov. Loimwe, Kengtung State—9123. First record for Burma.
- C. glabra* (Bl.) Copel. Kengtung State—Rock 2032, 2041, 2153, 2341; Mts. in Tenasserim—Parish; Taungyeghat, Pegu Dist.—328.
- C. khasyana* (Moore) Copel. Between Sadon and Yunnan border—Rock 7431; Khunpoye, Kungtung State—9247.
- C. latebrosa* (Wall.) Copel. Mergui—Maymyo Herb.
- C. oldhami* (Bedd.) Copel. Moulmein—Clarke & Beddome; Mooleyit—Parish.
- C. spinulosa* Wall. Namkham—619, 20. First record for Burma.
- C. umbrosa* Holttum. Taungwine, Moulmein—8854. First record for Burma.

PERENEMACEAE Presl, emend.

(Ching 1940b)

11. *Diacalpe* Blume

- D. aspidioides* Bl. Mooleyit, Tavoy—Beddome and Clarke; Mt. Nwalabo, Tavoy—Parish; Moulmein—Clarke; Mogok—125; Namkham—252, 260; Sin Lum Kaba—305, 307; Bantai, Kengtung State—9252.

ASPIDIACEAE Presl, emend.

(Ching 1940b)

TRIBE 1. DRYOPTERIDAE

12. *Dryopteris* Adanson, sensu propria.

(Ching 1938c)

- D. scottii* (Bedd.) Ching. Sin Lum Kaba—358, 376; Haka, Chin Hills—7415.
- D. stenolepis* (Bak.) C. Chr. Kambaiti Valley—Rock 7507; Namkham—321.
- D. atrata* (Wall.) Ching. Kengtung State—Rock 2207; Kengtung—9236; Sin Lum Kaba—330; Falam, Chin Hills—7254; Haka, Chin Hills—7505, 7370.
- D. paleacea* (Sw.) C. Chr. Between Sadon and the Yunnan border—Rock 7506; Sin Lum Kaba—334, 391; Haka, Chin Hills—7510.
- D. odontoloma* (Moore) C. Chr. Sin Lum Kaba—333; Taungteik, Chin Hills—7247; Haka, Chin Hills—7708; Stilwell Rd.—Young. First records for Burma.
- D. chrysocoma* (Christ) C. Chr. Mt. Popa—545, 6614. First records for Burma.
- D. cochleata* (Don) C. Chr. Kengtung State—Rock 2265, 2245; Kengtung—9173, 9174, 9174A; Taunggyi—178; Mt. Popa—547; Kalemmyo, Chin Hills—7220, 604.
- D. labordii* (Christ) C. Chr. Namkham—229. First record for Burma.

- D. marginata* (Wall.) Christ. Between Sadon and the Yunnan border—Rock 7504.
D. angustifrons (Moore) C. Ktze. Burma—Mebold.
Dryopteris sparsa (Ham.) Ktze. Tenasserim Distt.—Parish; Sadon to Yunnan border—Rock 7503; Sin Lum Kaba—277, 345, 411; Mogok—328; Namkham—12, 311; Pangwai, Kengtung State—9239, 9103, 9131; Stilwell Rd.—Young 51.
D. hendersoni (Bedd.) C. Chr. Namkham—240, 250. First records for Burma.

13. *Rumohra* Raddi
 (Ching 1934b)

- R. assamica* (Kuhn) Ching. Stilwell Rd., Burma-Assam border—Young. First record for Burma.
R. aristata (Forst.) Ching. Burma—Parish; Stilwell Rd.—Young 84.
R. speciosa (Don) Ching. Namkham—255, 301; Pangwai, Kengtung State—9201. First records for Burma.
R. simulans Ching. Namkham—317; Nawng Heng, Burma-Yunnan border 292. First records for Burma.
R. henryi (Christ) Ching. Kengtung State—Rock 2233; Sin Lum Kaba—340.
R. diffracta (Bak.) Ching. Loimwe, Kengtung State—9120; Nam Tamai Valley, 4000 ft.—Ward 9159. First records for Burma.

14. *Polystichum* Roth.

- P. thompsoni* (Hk. f.) Bedd. Adung River, Burma-Tibet frontier—Ward 9186. First record from Burma.
P. deltodon (Bak.) Diels. Maymyo—7. First record for Burma.
P. obliquum (Don) Moore. Goteik Gorge—212. First record for Burma.
P. auriculatum (L.) Presl. Stilwell Rd.—Young.
P. neolobatum Nakai (?). Taungteik, Chin Hills—7541. First record for Burma.
P. attenuatum Ching. Namkham—30, 253; Mogok—104; Sin Lum Kaba—332. First records for Burma.
P. chunii Ching. Namkham—259, 303. First records for Burma.
P. pseudotsus-simense Ching. Burma-Ind. Fil. III.
P. biaristatum (Bl.) Moore. Kengtung State—Rock 2116, 2117, 2309; Sin Lum Kaba—403.
P. biaristatum form. Sin Lum Kaba—359.
P. setiferum (Forsk.) Moore. Mogok—128, 145; Chin Hills; Falam—7276; Yetagone—7542; Taungteik—7299.
P. setiferum (Forsk.) Moore var. or sp. Falam—7280.
P. setiferum (Forsk.) Moore var. or sp. Falam—7302, 7303, 7372; Haka—7509.
P. yunnanense Christ. Sin Lum Kaba—358?; Mogok—129?; Haka—7508, 7782, 7784; between Sadon and Yunnan border—Rock 7521.
P. punctiferum C. Chr. Between Sadon and Yinan border—Rock 7522.

15. *Cyclopeltis* J. Smith

- C. presliana* (J. Sm.) Berkeley. Burma—Ind. Fil.

16. *Microchlaena* Ching
 (Ching 1938b)

- M. yunnanensis* (Christ) Ching. Kengtung State—Rock 2212; Pangwai, Kengtung State—9195, 9243; N'Bapa—270.

17. *Cyrtomium* Presl

- C. hookerianum* (Presl) C. Chr. Sin Lum Kaba—352. First record for Burma.

TRIBE 2. ASPIDIEAE

18. *Ctenitis* C. Chr.

- C. clarkei* (Bak.) Ching. Between Sadon and the Yunnan border—Rock 7405.
C. rhodolepis (Cl.) Ching. Maymyo—425; Taunggyi—9322. First records for Burma.

19. *Pteridrys* C. Chr. & Ching

- P. australis* Ching. Valley of the Meh Len, Kengtung State—Rock 2141.

P. cnemidaria (Christ) Ching. Tenasserim Distt.—Parish; Kengtung State—Rock 2140; Taunggyi—9291.

20. *Ctenitopsis* Ching
(Ching 1938b)

C. sagenioides (Mett.) Ching. Tenasserim—Parish.

C. fuscipes (Wall.) Ching. Taungup—Lace 2936; Pyinmana—7121; Zwagabin, Moulmein Distt.—7022.

C. setulosa (Bak.) Ching. Khunpoye, Kengtung State—9259. First record for Burma.

21. *Egenolfia* Schott
(Ching 1931d)

E. appendiculata (Willd.) J. Sm. Tenasserim—Parish; Taungwine, Moulmein—6849; Pyinmana—7120; Stilwell Rd.—Young.

E. sinensis (Bak.) Maxon. Moulmein (?)—6621, 6657, Pyinmana—7130; Loimwe, Kengtung—9140. First records for Burma.

E. bipinnatifida J. Sm. Tenasserim—Parish; Moulmein—6751.

E. helferiana (Kunze) C. Chr. Oktada, Martaban Hills, Kalama Range—Rock 759; Kyain, Amherst Distt.—6867.

E. helferiana var. *incisa*. Lower Burma—Rock 759.

E. nodiflora (Bory) Fée. Mawlaik, Upper Chindwin Distt.—Rock 823; type from Pegu.

22. *Tectaria* Cav.
(Ching 1931f)

T. polymorpha (Wall.) Copel. Moulmein—Parish 145; Thandaung—6750; Goteik Gorge—209; Namkham—9,236; N'Bapa—272; Kengtung—9167; Rock 1954, 2084, 2090.

T. heterosora (Bak.) Ching. Stilwell Rd.—Young.

T. tenerifrons (Hk.) Ching. Moulmein—Parish 92 (type).

T. chattagramica (Cl.) Ching. Sandwut—Lace 4799, 5178.

T. vasta (Bl.) Copel. Kengtung State—Rock 1938, 1957, 2132, 2139.

T. subtriphylla (Hk. & Arn.) Copel. Burma. Parish; Htam Sang Caves, Hopong State—8094.

T. subtriphylla (Hk. & Arn.) Copel. var. *appr.* *T. Rockii*. Zwagabin, Moulmein—7043; Goteik Gorge—208.

T. rockii C. Chr. Goteik Gorge—Lace 4857 (1909); 208A, 9525; Takaw Ferry—9288; Sampu, Namkhok State—8345; Kanpetlet, Chin Hills—8570.

T. irregularis (Presl) Copel. Tenasserim—Parish.

T. irregularis (Presl) Copel. var. *difformis* Bl. Mergui—Maymyo Herb. Kyaukthanba, Pyinmana—7121.

T. subpedata (Harr.) Ching. Namkham—28.

T. decurrens (Presl) Copel. Goteik Gorge—Lace 4993 (1909).

T. variolosa (Wall.) C. Chr. Tavoy—7977, Moulmein—567, 6844; Pegu—Clarke; Syriam—462; Mt. Popa—6626 (?).

T. ebenina (C. Chr.) Ching. Kalemio—7219; Tiddim, Chin Hills—623 (?).

T. coadunata (Wall.) Ching. Moulmein—Parish, Maymyo Herb. 561.

T. multicaudata (Wall.) Ching. Moulmein and Mergui—Beddome; Chappedaung—Wallich.

23. *Bolbitis* Schott

B. contaminans (Wall.) Ching. Burma—Beddome.

B. deltigera (Wall.) C. Chr. Zwagabin, Moulmein—7029; Yetagone, Chin Hills—7766.

B. heteroclita (Presl) Ching. Tenasserim Distt.—Parish.

B. sculpturatus (Fee) Ching. Tenasserim Distt.—Parish.

B. undulata (Wall.) Ching. Martaban—Parish (1827); Zwagabin, Moulmein—7014; Thandaung (?)—6711.

24. *Stenochlaena* J. Smith

S. palustris (Burm.) Bedd. Tenasserim—Parish; Moulmeingyun, Henzada—6903; Rangoon—6537; Thandaung—58.

S. sorbifolia (L.) J. Sm. Tenasserim—Beddome; Packchan—Parish.

25. *Lomagramma* J. Smith
(Holttum 1937b)

L. matthewii (Ching) Holttum. Salween River, Road to Kengtung—9289. First record for Burma.

THELYPTERIDACEAE Ching
(Ching 1940b)

TRIBE 1. THELYPTERIDEAE

26. *Thelypteris* Schmidel
(Ching 1936c)

T. aurita (Hk.) Ching. Upper Burma—G. Forrest.

T. oppositipinna (v.A.v.R.) Ching. Sin Lum Kaba—357. First record for Burma.

T. brunnea (Wall.) Ching. Namkham—274, 312. First records for Burma.

T. chlamydophora (Rosenst.) Ching. Burma—Ind. Fil. III.

T. ciliata (Wall.) Ching. Kengtung State—Rock 2185, 2206; Valley of the Nam Tamai, Burma—Tibet frontier—Ward 9117; Stilwell Rd.—Young 7; Thandaung —6782.

T. erubescens (Wall.) Ching. Falam, Chin Hills—7270, 7271; Haka, Chin Hills—7390, 7413. First records for Burma.

T. tuberculifera (C. Chr.) Ching. Kalaw—13A; Taunggyi—176; Loimwe, Kengtung State—9106; Falam, Chin Hills—7239; Haka, Chin Hills—7611. First records for Burma.

T. xylodes (Kze.) Ching. Kengtung State—Rock 2234; Loimwe—523 (?); Mogok—154; Sin Lum Kaba—276; Falam, Chin Hills—7250.

T. falciloba (Hk.) Ching. Kengtung State—Rock 2082; Kengtung—9182, 9225; Maymyo—8; Mogok—143.

T. ochthodes (Kze.) Ching. Thandaung—6778; Kalaw—13; Loimwe, Kengtung—9106A; Mogok—148; Haka, Chin Hills—7573. First records for Burma.

T. duclouxii (Christ) Ching. Burma—Maymyo Herb. 566. First records for Burma.

T. glanduligera (Kze.) Ching. Sin Lum Kaba—459 (probably). First record for Burma.

T. flaccida (Bl.) Ching. Sin Lum Kaba—379. First record for Burma.

T. uliginosa (Kze.) Ching. Anisakan—427; Mt. Popa—6619. First records for Burma.

T. ornata (Wall.) Ching. Burma—Parish; East of Bhamo—Rock 7842.

27. *Lastreopsis* Ching

L. parishii (Hk.) O. Ktze. Moulmein—Parish.

28. *Hypodematium* Kunze
(Ching 1935b)

H. crenatum (Forsk.) Kuhn. Anisakan—422, 428; Mt. Popa—548, 6620; Yetagone, Chin Hills—7333. First records for Burma.

TRIBE 2. GONIOPTERIDEAE

29. *Cyclosorus* Link
(Ching 1938a)

C. crinipes (Hk.) Ching. Kengtung State—Rock 2089; Yanka, Kengtung—9234; Mong Nai, S. S. S.—7852; Takaw Ferry—9287; Sin Lum Kaba—347; Mogok—151; Kyaukthanba, Pinyinmana—7125.

C. extensus (Bl.) Ching. Tenasserim—Parish.

C. multijugus (Bak.) F. G. D. Falam, Chin Hills—7289. First record for Burma.

C. interruptus (Willd.) Ching. Tenasserim Distt.—Parish; Kyauktalon, Moulmein Distt.—6837; 6842; Mt. Popa—6604; Goteik Gorge—204.

C. gongylodes (Schkuhr.) Link. Kyain, Moulmein—6859; Mingaladon—603; Inle Lake, S. S. S.—187, 7880; Kengtung—9190. First records from Burma.

C. molliusculus (Wall.) Ching. Kengtung State—Rock 3187, 2189.

C. parasiticus (L.) Farwell. Thandaung—66; Namkham—300; Pangwai, Kengtung State—9203. First records for Burma.

- C. subpubescens* (Bl.) Ching. Kyauktalon, Moulmein—6837A, 6840, 6841; Kyain, Moulmein—6858; Mt. Popa—6627A; Rangoon—188, 6627; Maymyo—415, 423; Goteik Gorge—210; Namkham—222; Falam, Chin Hills—7248; Pyinmana—7109.
- C. burmanicus* Ching. Kengtung State—Rock 2247.
- C. meeboldi* (Rosenst.) Ching. Tenasserim—Meebold 2152 (type).
- C. truncatus* (Poir.) Farwell. Kengtung State—Rock 1966; Yanka, Kengtung State—9226 sens lat.
- C. hirtisorus* (C. Chr.) Ching. Kengtung State—Rock 2208 (type), 2235; Loimwe, Kengtung—514; Mogok—55A (?).
- C. subelatus* (Bak.) Ching. Kengtung State—Rock 2113; Kengtung—9185, 9185A; Mogok—152; Namkham—323, 324.

30. *Goniopteris* Presl

(Ching 1938a)

- C. prolifera* (Retz) Presl. Mergui—Hope; Kengtung State—Rock 2115; N'Bapa—288; Kalemyo—7202; Tiddim, Chin Hills—601.

31. *Abacopteris* Fee emend.

(Ching 1938a)

- A. triphylla* (Sw.) Ching. Tenasserim—Parish; Kyain, Amherst Distt.—6866; Stilwell Rd.—Young 39.
- A. triphylla* var. *parishii* (Bedd.) Ching. Tenasserim—Beddome.
- A. rubra* Ching. Thandaung—54, 6787; Loimwe, Kengtung—532, 9122.
- A. rubra* var. *hirsuta* Ching. Kengtung State—Rock 2136; Maymyo 41; Stilwell Rd.—Young 33.
- A. presliana* Ching. Namkham—246; Yetagone, Ching Hills—7309.
- A. multilineatum* (Wall.) Ching. Moulmein—Parish; Kyain, Amherst Distt.—6856; Sin Lum Kaba—339; Namkham—39, 237; N'Bapa—304; Kengtung State—Rock 1936, 1938, 2142.
- A. penangiana* (Hk.) Ching. Maymyo—412, 421A, 421 (?). First records from Burma.

ASPLENIACEAE Presl

(Ching 1940b)

TRIBE 1. ATHYRIAE

32. *Athyrium* Roth.

- A. acrostichoides* (Sw.) Diels. Sin Lum Kaba—266. First record for Burma.
- A. atkinsoni* Bedd. Sin Lum Kaba—354. First record for Burma.
- A. australe* (R. Br.) Presl. Burma—Beddome.
- A. boryanum* Tagawa (= *Dryoathyrium* Ching). Toungoo—Maymyo Herb. 565.
- A. brevisorum* (Wall.) Moore. Taungdong Mts. near Ava—Wallich.
- A. dissitifolium* (Bak.) C. Chr. Kengtung State—Rock 2666, Rock 2691; Loimwe—511, 512, 9208; Taunggyi—179, 9390; Kalaw—23; Maymyo—418 (?); Falam, Chin Hills—7351; Haka, Chin Hills—7570.
- A. dissitifolium* f. *subbipinnata*. Tiddim Chin Hills—600; Haka—7694.
- A. drepenopterum* (Kze.) R. Br. Between Sadon and Yunnan border—Rock 4776; Mogok—112, 144.
- A. drepenopterum* var. *funebre* Christ. Between Sadon and Yunnan border—Rock 7477.
- A. falcatum* Bedd. Mt. Popa—541. First record for Burma.
- A. macrocarpum* (Bl.) Bedd. Near Kambaiti—Rock 7484.
- A. nigripes* (Bl.) Moore. Between Sadon and Yunnan border—Rock 7519.
- A. niponicum* (Mett.) Hance. Taunggyi—177, 177A. First record for Burma.
- A. procerum* (Wall.) Milde. Mogok—131; N'Bapa—280, 286; Haka, Mossy Forest—7511. First records for Burma.
- A. setiferum* C. Chr. Between Sadon and Yunnan border—Rock 7518, Rock 7520.
- A. spectabile* (Wall.) Presl. Goteik Gorge—211; Takaw, Kengtung State—9286. First records for Burma.
- A. strigillosum* Moore. Between Sadon and Yunnan border—Rock 7420 (?).

33. *Cystopteris* Bernhardt

C. tenuisecta (Bl.) Mett. Moulmein Mts.—Bedd.; Mooleyit, Tavoy—Parish.

34. *Diplazium* Swartz

D. bantamense Bl. Tenasserim—Parish; Stilwell Rd.—Young.

D. dilatatum Bl. f. *diversifolium* (Wall.) Kengtung State—Rock 2134.

D. dilatatum Bl. f. *latifolium* (Don). Kengtung State—Rock 2036, Rock 2184; between Sadon and Yunnan border—Rock 7443; Loimwe—9141A; Mogok—102, 149, 342.

D. esculentum (Retz) Sw. Kengtung State—Rock 2114; Teeyang, Tenasserim Distt.—Parish; Tavoy—8015; Kyain, Amherst Distt.—6857; Kalemio—7228.

D. japonicum (Thbg.) Bedd. Stilwell Rd.—Young 78.

D. lanceum (Thbg.) Presl. Stilwell Rd.—Young 7. First record for Burma.

D. leptophyllum (Bak.) Christ. Kengtung—9172A; Haka, Chin Hills—7572. First records for Burma.

D. lobbianum (Hk.) Moore. Kengtung State—Rock 1937.

D. megaphyllum (Bak.) Christ. Salween River at Kengtung Road—9290. First record for Burma.

D. opacum (Don) Christ. Loimwe, Kengtung State—9141. First record for Burma.

D. pallidum (Bl.) Moore. Tenasserim—Parish.

D. peterseni Kze. Thandaung (?)—6736. First record for Burma.

D. polypodioides Bl. Between Sadon and Yunnan border—Rock 7434; Takaw, Kengtung State—9294; Haka, Chin Hills—7482.

D. siamense C. Chr. f. *acuminata*. Loimwe, Kengtung—506. First record for Burma.

D. sikkimense (Cl.) C. Chr. Kengtung State—Rock 2183.

D. silvaticum (Bory) Sw. Chappedong Hill, Burma—Clarke.

D. tomentosum Bl. Tenasserim—Parish.

D. viridissimum Christ. Kengtung State—Rock 2131.

35. *Diplaziopsis* C. Chr.

D. javanica (Bl.) C. Chr. Stilwell Rd.—Young 29. First record for Burma.

TRIBE 2. ASPLENIEAE

36. *Phyllitis* Hill

P. delavayi (Franch) C. Chr. Upper Burma—Ind. Fil.

37. *Thamnopteris* Presl.

T. nidum L. Tenasserim Distt.—Parish; beyond Sadon near Yunnan border—Rock 7467; Loiye, Bhamo Distt.—410; Yanka, Kengtung State—9229.

T. phyllitidis (Don) Presl. Kengtung State—Rock 2181.

T. grevellei (Wall.) Moore. Tavoy Island—Parish.

38. *Asplenium* L.

A. ensiforme Wall. Ta-ok—Parish; Tenasserim—Hope; Moulmein—Clarke; Nattaung, Karen—9457; Ashe-myin-Anauk-myin, Lawk Sawk State—8703, 8717; Sampu, Namkhok State—8359; Mt. Victoria, Chin Hills; 8595, 8598; Mogok, Taungme—110; Sin Lum Kaba—402; N'Bapa—209; Pangyang, Manglun State—8071; Adung Valley, Burma-Tibet frontier—Ward 9334.

A. griffithianum Hk. Mergui and Tavoy—Beddome; Stilwell Rd.—Young 64; Burma-Tibet frontier, Nam Tamai Valley—Ward 9165.

A. amboinense Willd. Mergui and Tavoy—Parish.

A. normale Don. Ta-ok—Parish; Loimwe, Kengtung State—9121; Stilwell Rd.—Young 82.

A. normale var. *minus*—Kambaiti—Rock 7508.

A. longissimum Bl. Moulmein southwards—Parish.

A. wightianum Wall. Burma—Beddome.

A. tenerum Forst. Tenasserim Distt.—Parish.

A. pellucidum Lam. Madremacan Is., Nergui—Parish; Moulmein—Bedd.

- A. cheilosorum* Kunze. Zwakabin—Parish; Nattaung, Karrenni—9479, 9418; between Sadon and Yunnan border—Rock 7425; Stilwell Rd.—Young 89.
- A. unilaterale* Lam. Zwegabin, Moulmein—7024; Nattaung, Karrenni—9477; Mt. Popa—6602.
- A. unilaterale* var. *rahaoense* (Yabe) Hay. Between Pang Ma Ki Hat and the Siamese border—Rock 1947; Stilwell Rd.—Young 12.
- A. unilaterale* var. *delicatulum* Par. Mergui—Parish; Ta-ok—Parish.
- A. unilaterale* var. *udum* Atk. Htam Sang Caves, Hopong State—8269; Sampu, Namkhok State—8291; Mt. Victoria—8456, 8498, 8568; Haka—7574; Stilwell Rd.—Young 68.
- A. adiantoides* (L.) C. Chr. Moulmein southwards—Clarke; Hopong, Hopong State—8264 (?), 8087 (?).
- A. macrophyllum* Sw. Stilwell Rd.—Young 16. First record for Burma.
- A. urophyllum* Wall. Henzada—6900. First record for Burma.
- A. exiguum* Bedd. Kalaw—15; Taunggyi—8093, 9391. First records for Burma.
- A. rockii* C. Chr. Near N'Bapa ford, Burma-Yunnan border 290A. First record for Burma.
- A. laciniatum* Don. Kalaw—16; between Sadon and Yunnan border—Rock 7422.
- A. planicaule* Wall. Between Sadon and Yunnan border—Rock 7417; Mogok—103, 120; Taunggyi—9313; Thandaung 6714A; Haka, Chin Hills—7366, 7556, 7579.
- A. crinicaule* Hance. Mt. Nwalabo, Tavoy Distt. (?)—8245; Sin Lum Kaba—398; Stilwell Rd.—Young. First records for Burma.
- A. praemorsum* Sw. Thandaung—6714. First record for Burma.
- A. nitidum* Sw. Tenasserim Distt.—Parish.
- A. cuneatum* Lam. Stilwell Rd.—Young. First record for Burma.
- A. bullatum* Wall. Adung Valley, Burma-Tibet frontier—Ward 9185.
- A. tenuifolium* Don. Kalamataung, Martaban—Parish; Bernardmyo, Mogok—123; Mt. Victoria, Chin Hills—8515; Ashe-myin Anauk-myin, Lawk Sawk State—8709; Sampu, Namkhok State—8332; Pangwai, Kengtung State—9215; Pangyang, Manglun State—8073.
- A. schilleifolium* (Lam.) C. Chr. Maymyo Herb. 588.

39. *Ceterach* Garsault

- C. paucivenosa* Ching. Adung Valley, Burma-Tibet frontier—Ward 9230. First record for Burma.

OLEANDRACEAE Ching (Ching 1940b)

40. *Oleandra* Cav.

- O. cumingii* J. Sm. Taungwine Range, Moulmein—Parish; Madremacan, Mergui—Parish.
- O. musifolia* (Bl.) Presl. Thandaung—60. First record for Burma.
- O. neriiformis* Cav. Dauna-taung east of Moulmein—Parish.
- O. undulata* (Willd.) Ching. Moulmein—Baker; Kengtung State—Rock 2026.
- O. wallichii* (Hk.) Presl. Burma—Beddome.

BLECHNACEAE Ching (Ching 1940b)

TRIBE 1. BLECHNEAE

41. *Blechnum* L.

- B. orientale* L. Moulmein—Parish; Taungwine, Moulmein—6350; Kyain, Amherst Distt.—6855; Taung Thonta, Tavoy—8011; Rangoon—8131; Thandaung—59; Mogok—620; Namkham—4, 18, 19, 223; Pangyang, Manglun State—8084.

TRIBE 2. WOODWARDIEAE

42. *Woodwardia* Smith (Ching 1931a)

- W. japonica* (L.) J. E. Smith. Kengtung State—Rock 2006; Loimwe, Kengtung State—9102.
- W. unigemmata* Nakai. Adung Valley, Burma-Tibet frontier—Ward 9309. First record for Burma.

TRIBE 3. BRAINEAE

43. *Brainea* J. Sm.

B. insignis (HK.) J. Sm. Mooleyit, Tavoy—Parish; Yonzalin Mts.—Parish; Mogok—139; east of Pangyang, Manglun State—very common, trunks 3 ft. high; Loimwe—9235; Kengtung State—Rock 2028.

PLATYCERIACEAE Ching

(Ching 1940b)

44. *Platycerium* Desv.

P. coronarium (Konig) Desv. Mergui and Islands—Parish.

P. wallichii Hk. Tenasserim—Beddome; Taungwine, Moulmein—Parish; Moulmein—31; Pyinmana—500; Thandaung—8397; Anisakan, Maymyo—419; Kalembo—7223; Bhamo.

GRAMMITACEAE Presl emend.

(Ching 1940b)

45. *Ctenopteris* Blume

C. khasiana (Hk.) Dickason. Nam Tamai Valley, Upper Burma—Ward 9146. First record for Burma.

C. subfalcata (Bl.) Dickason. Between Sadon and Yunnan border—Rock 7400; Nattaung, Karenni—9460; Haka, mossy forest—7578.

POLYPODIACEAE Presl (sensu propria)

(Ching 1940b)

SUBFAMILY 1. POLYPODIOIDEAE

45. *Polypodium* L.

(Ching 1933d)

P. manmeiense Christ. Taunggyi—471, 8112, 8115, 9050; Loimwe, Kengtung State—534; Pangyang, Manglun State—8059; Nattaung, Karenni—9458. First records for Burma.

P. microrrhizoma Clarke. Maymyo Herb. 25678.

P. nipponicum Mett. Burma—Ind. Fil.

P. amoenum Wall. Between Sadon and Yunnan border—Rock 7455; Pangyang, Manglun State—8058; Nattaung, Karenni—9471; Mogok—137; Sin Lum Kaba—375; Stilwell Rd.—Young 83.

P. argutum Wall. Between Sadon and Yunnan border—Book 7500.

P. pseudoconnatum Copel. Kyaukse Taung, Tavoy Distt.—8009.

P. subauriculatum Bl. Tenasserim Distt.—Parish.

P. beddomei Bak. Waytamargay, S. S. S.—Parish.

SUBFAMILY 2. PLEOPELTIOIDEAE

47. *Neocheiropteris* Christ

(Ching 1933b)

N. ensata (Thbg.) Ching. Stilwell Rd.—Young 11. First record for Burma.

N. phyllomanes (Christ) Ching. Htam Sang Caves, Hopong State—8268; Namkham—40; Kanpetlet, Chin Hills—8429; Yetagone, Chin Hills—7752. First records from Burma.

N. lancifolia (Alston) Dickason. Nam Tamai, Upper Burma—Ward 9172 (type).

48. *Lepisorus* (J. Sm.) Ching

(Ching 1933b)

L. contortus (Christ) Ching. Sin Lum Kaba—633; Kalaw—629. First records for Burma.

L. excavatus (Bory) Ching var. *scolopendrinum* (Ham.) Ching. Maymyo Herb.—1774; Sin Lum Kaba—365 probably. First records for Burma.

L. macrosphaerus (Bak.) Ching. Kalaw—631; Sin Lum Kaba—367, 371, 377. First records from Burma.

L. macrosphaerus var. *asterolepis* (Bak.) Ching. Taunggyi—8378, 9047; Sampu, Namkhok State—8363; Molahein Mt., Lawk Sawk State—8744; Mt. Popa—563; Mt. Victoria—8486,

8590; Falam, Chin Hills—7244; Haka, Chin Hills—7399, 7418, 7598. First records for Burma.

L. obscure-venulosus (Hay.) Ching. Kalaw—630, 628 (near). First records for Burma.

L. oligolepidus (Bak.) Ching. Between Sadon and Yunnan border—Rock 7494; Thandaung—6726.

L. oosphærus (C. Chr.) Ching. Kalaw—9592; Taunggyi—8125, 8786, 9048; Loimwe, Kengtung State—502. First records for Burma.

L. pseudonudus Ching. Between Sadon and Yunnan border—Rock 7498; Thandaung—6786.

L. sinensis (Christ) Ching. Between Sadon and Yunnan border—Rock 7488; Lin Lum Kaba—364.

L. sordidus (C. Chr.) Ching *forma rostrata* (C. Chr.) Ching. Between Sadon and Yunnan border—Rock 7509.

L. subconfluens Ching. Namkham—302A (?). First record for Burma.

L. sublinearis (Bak.) Ching. Between Sadon and Yunnan border—Rock 7424; Loi Maing, Sampu, Namkhok State—8364; Haka, Chin Hills—7558, 7576.

L. sublinearis var. Kalaw—4. First record for Burma.

L. thunbergianus (Klf.) Ching. Between Sadon and Yunnan border—Rock 7421; Sin Lum Kaba—633; Mogok-Bernardmyo Rd.—172; Namkham—632; Mt. Popa—560; Thandaung—51.

49. *Hymenolepis* Kaulfuss
(Christensen 1929)

H. henryi Hieron. Stilwell Rd.—Young. First record for Burma.

50. *Lemmaphyllum* Presl
(Christensen 1929)
(Ching 1933b)

L. subrostratum (C. Chr.) Ching. Dauna Taung, east of Moulmein—Parish; Sampu, Namkhok State—8353; between Sadon and Yunnan border—Rock 7493; Falam, Chin Hills—7273; Stilwell Rd.—Young 9.

TRIBE 2. PHYMATODEAE

51. *Phymatodes* Presl
(Ching 1933d)

P. griffithiana (Hk.) Ching. Between Sadon and Yunnan border—Rock 7528; Yatagon e, Chin Hills—7350.

P. rhyncophylla (Hk.) Ching. Dauna Taung. Parish; Mooleyit, Tenasserim—Beddome; between Sadon and Yunnan border—Rock 7513; Loiye—Sin Lum Kaba Rd.—390; Nattaung, Karenni—9453.

P. crenato-pinnata (Cl.) Ching. Kalaw—9588; Taunggyi—181, 8771; Loimwe, Kengtung State—526. First records for Burma.

P. trisecta (Bak.) Ching. Maymyo Herb.

P. oxyloba (Wall.) Presl. Daung Taung—Parish; Thandaung—53; Nattaung, Karenni—9452; Molahein Mt., Lawksawk State—8760; Pangyang, Manglun State—8066; Loimwe, Kengtung State—525; Tiddim, Chin Hills—626.

P. sp. nov. Mt. Popa—538. First record for Burma.

P. lucida (Roxb.) Ching. Kalaw—27, 405; Sin Lum Kaba—341. First records for Burma.

52. *Selligaea* Bory emend.
(Ching 1933c)

S. fée Bory. Tenasserim and Mergui—Parish.

53. *Microsorium* Link
(Ching 1933c)

M. normale (Don) Ching. Mooleyit, Tenasserim—Beddome; Mergui—Parish; between Sadon and Yunnan border—Rock 7510; Sampu, Namkhok State—8338; Ashe-myin Anaukmyin, Lawksawk State—8702.

- M. hymenodes* (Kze.) Ching. Yetagone, Chin Hills—7754; Stilwell Rd.—Young. First records from Burma.
- M. superficiale* (Bl.) Ching. Between Sadon and Yunnan border—Rock 7497; Sin Lum Kaba—400; Pangwai, Kengtung State—9202; Taungteik, Chin Hills—7298.
- M. punctatum* (L.) Copel. Kengtung State—Rock 2138; Bhamo—412; Goteik Gorge—207; Hrawng Vung, Haka, Chin Hills—7637; Moulmeingyun—6913; Moulmein—6852; Tavoy—7986.
- M. zippelii* (Bl.) Ching. Sin Lum Kaba—408. First record for Burma.
- M. membranaceum* (Don) Ching. Tenasserim Distt.—Parish; between Sudan and Yunnan border—Rock 7478; Thandaung—52. Taunggyi—8118, 9029.
- M. hancockii* (Bak.) Ching. Tenasserim—Parish; Kengtung State—Rock 2135; Loimwe, Kengtung State—9143.
- M. zosteriforme* (Wall.) Ching. Mooleyit, Tenasserim—Parish.
- M. pieropus* (Bl.) Ching. Kyain, Amherst Distt.—6866A; Stilwell Rd.—Young 32.

54. *Colysis* Presl
(Ching 1933c)

- C. hemionitidea* (Wall.) Presl. Tenasserim Distt.—Parish.
- C. pedunculata* (Hk. & Grev.) Ching. Stilwell Rd.—Young. First record for Burma.
- C. henryi* (Bak.) Ching. Stilwell Rd.—Young 67. First record for Burma.
- C. latiloba* Ching. Sin Lum Kaba—349. First record for Burma.
- C. flexiloba* (Christ) Ching var. *undulato-repanda* (C. Chr.) Ching. Sin Lum Kaba—407. First record from Burma.
- C. elliptica* (Thbg.) Ching. Tenasserim—Parish; Stilwell Rd.—Young 69.
- C. elliptica* var. *pothifolia* (Don) Ching. Ashe-myin Anauk-myin, Kawksawk State—8710; Sampu, Namkhok State—8295, 8324; Loimwe, Kengtung State—9144; Namkham 319.

55. *Leptochilus* Kaulf.
(Ching 1933c)

- L. decurrens* Bl. Kengtung State—Rock 2137; Goteik Gorge—214; Thandaung—6790.
- L. lanceolatus* Fée. Burma—Beddome.
- L. axillaris* (Cav.) Kaulf. Tenasserim—Parish; Pegu—Clarke.

56. *Arthromeris* J. Smith
(Ching 1933d)

- A. tenuicauda* (Hk.) Ching. Tibetan-Burmese border—Ching.
- A. wallichiana* (Spreng) Ching. Moulmein—Clarke; Sin Lum Kaba—Loije Rd. 42nd mile—350.
- A. wardii* (Cl.) Ching. Maikha-Salween—Forrest 25974.
- A. lehmanni* (Mett.) Ching. Dauna Taung—Parish; Upper Burma—Forrest 24922; Kalaw—9591; Taunggyi—180, 8104, 8787, 8698, 8699.
- A. lehmanni* var. *mairei* (Brause) Ching. Tiddim, Chin Hills—627. First record for Burma.
- A. lehmanni* var. *auriculata* Ching. Upper Burma—Forrest 24922.
- A. himalayense* (Hk.) Ching. Dauna Taung—Parish.

57. *Pseudodrynaria* C. Chr.

- P. coronans* (Wall.) C. Chr. S. E. of Moulmein—Parish; Toungoo—Parish; Tenasserim—Beddome; Yanka, Kengtung State—9222; Manhsum, Manglun State—9678; Mong Yang, Kengtung State; Stilwell Rd.—Young; between Muang Len and Muang Hpyak—Rock 2033.

58. *Drynaria* Bory

- D. propinqua* (Wall.) J. Sm. Kalaw—6A; Maymyo—420; Taunggyi—478; Pangwai, Kengtung State—7882, 9207; Mt. Popa—558; Kalemyo—7230; Stilwell Rd.—Young.
- D. quercifolia* (L.) J. Sm. Moulmein—578; Rangoon (very common)—163, 168, 190; Wakema—7822; Bhamo—414; Kalewa—7190.

59. *Pyrrhosia* Mirbel

(Ching 1935a)

= *Cyclophorus* Desv.

- C. mollis* (Kze.) Presl. Shan Hills—Collett; Thandaung—6745; Kalaw—625; Taunggyi—7845, 8113, 8657; Hopong—8262; Sin Lum Kaba—343; Haka, Chin Hills—7420.
- C. flocculosus* (Don) C. Chr. Between Sadon and Yunnan border—Rock 7462; Mogok—170; Mt. Popa—493, 503; Kalaw—L. P. Khanna.
- C. penangianus* (Hk.) Ching. Tenasserim—Parish.
- C. stigmossus* (Sw.) Desv. Tenasserim—Beddome; Tavoy—Parish.
- C. beddomeanus* (Gies.) C. Chr. Wetwun, near Myamyo—62; Htam Sang Gaves, Hopong State—8100, 8261. First records for Burma.
- C. subfurfuraceus* (Hk.) C. Chr. Stilwell Rd.—Young. First record for Burma.
- C. pannosus* (Mett.) C. Chr. Tenasserim—Parish.
- C. nudus* (Gies.) C. Chr. Between Bhamo and Tengyueh—Rock 7825.
- C. heteractis* (Mett.) C. Chr. Between Sadon and Yunnan border—Rock 7491; Sin Lum Kaba—329, 356, 373, 397; Thandaung—65, 6713, 6781.
- C. lanceolatus* (L.) Alston. Mergui—Parish; Rangoon—164; Mt. Popa—557; Maymyo—417; Namkham—298; Stilwell Rd.—Young 18.
- C. spissus* (Bory) Desv. Tavoy—7989; Rangoon—6560, 8033, 8050; Syriam—464; Moulmeingyun—6921; Maubin Distt.—8056.
- C. confluens* (R. Br.) C. Chr. Tenasserim—Parish; Kyain, Amherst Distt.—6872.
- C. nummulariaefolius* (Sw.) C. Chr. Tavoy—Parish; Taung Thonta, Tavoy—8016; Namkhok State—fairly common.
- C. angustatus* (Sw.) Desv. Madremacan, Mergui—Parish.

60. *Drymoglossum* Presl

- D. piloselloides* (L.) Presl. Tavoy and Mergui—Parish; Kyaukme Taung, Tavoy—8008; Rangoon—106, 6699.

LOXOGRAMMACEAE Ching

(Ching 1940b)

61. *Loxogramme* Presl

- L. lanceolata* (Bl.) Presl. Stilwell Rd.—Young. First record for Burma.
- L. chinensis* Ching. N'Bapa, Burma-Yunnan border—290. First record for Burma.
- L. involuta* (Don) Presl. Namkham—249; Mogok—264; Sin Lum Kaba—336.
- L. avenia* (Bl.) Presl. Mongnai, S. S. S.—7854. First record for Burma.

ANTROPHYACEAE Ching

(Ching 1940b)

62. *Antrophyum* Kaulf.

- A. coriaceum* (Don) Wall. Mergui—Clarke; Mogok—140.
- A. obovatum* Baker. Between Sadon and Yunnan border—Rock 7501.
- A. parvulum* Blume. Sin Lum Kaba—399. First record for Burma.
- A. rectulatum* (Forst.) Klf. Tenasserim Distt.—Parish; Stilwell Rd.—Young.

VITTARIACEAE Presl emend.

(Ching 1940b)

63. *Vittaria* Smith

(Ching 1931e)

- V. elongata* Sw. Moulmein—Parish 83, 513; Moulmeingyun—6912.
- V. merrillii* Christ. Stilwell Rd.—Young. First record for Burma.
- V. sikkimense* Kuhn. Kalama Taung—Parish; Moulmein—Clarke; Tenasserim—Beddome; Pang Yang, Manglun State—9762; between Sadon and Yunnan border—Rock 7419.
- V. caricina* Christ. Mergui—Wight; between Sadon and Yunnan border—Rock 7395.

- V. linearifolia* Ching. Upper Burma—G. Forrest 26550.
V. flexuosa Fée. Thandaung—6746. First record for Burma.
V. scolopendrina (Bory) Thwait. Rangoon, Cabin Island in Victoria Lake. First record for Burma.
V. amboinensis Fée. Martaban—Beddome; Kalama Taung—Parish.
V. himalayensis Ching. Sin Lum Kaba—355. First record for Burma.
V. doniana Hieron. Between Sadon and Yunnan border—Rock 7423; Haka, Chin Hills—7368, 7557, 7580, 7696.
V. doniana var. *angusta* Hieron. Between Sadon and Yunnan border—Rock 7398.

ELAPHOGLOSSACEAE Ching
 (Ching 1940b)

64. *Elaphoglossum* Schott

- E. petiolatum* (Sw.) Urban. N'Bapa, Burma-Yunnan border—393. First record for Burma.

HYMENOPHYLLACEAE
 (Copeland 1933, 1937, 1938)

65. *Cephalomanes* Presl

- C. javanica* (Bl.) van den Bosch. Madremacan, Mergui—Parish; Zinyaik, Martaban—Maymyo Herb. 13429; Kyain, Amherst Distt.—6868.

66. *Crepidomanes* Presl

- C. bipunctatum* (Poiret) Copel. Moulmein—Parish.
C. latealatum (v. d. B.) Copel. Haka, Chin Hills—7559. First record for Burma.
C. latemarginale (Eaton) Copel. Moulmein—Parish.
C. plicatum (v. d. B.) Copel. Burma—Beddome.

67. *Hymenophyllum* Smith

- H. barbatum* (v. d. B.) Baker. Between Sadon and Yunnan border—Rock 7442; Stilwell Rd.—Young.

68. *Mecodium* Presl

- M. australe* (Willd.) Copel. Tenasserim—Parish; between Sadon and Yunnan border—Rock 7445.
M. insertum (Wall.) Copel. Tenasserim—Parish; Thandaung—11, 6761.
M. polyanthos (Sw.) Copel. Tenasserim—Parish; between Sadon and Yunnan border—Rock 7396.

69. *Meringium* Presl

- M. denticulatum* (Sw.) Copel. Moulmein Mts.—Parish; Stilwell Rd.—Young.

70. *Microgonium* Presl

- M. henzaianum* (Parish) Copel. Henzai Basin—Parish; Moulmein and Pegu—Parish.
M. molleyi (v. d. B.) Copel. Tenasserim—Beddome.
M. parvifolium (Bak.) Copel. Taungkya Tsakan, between Kaukareek and Myawadi—Parish.

71. *Vandenboschia* Copeland

- V. auriculata* (Bl.) Copel. Mergui—Maymyo Herb. 13432, Stilwell Rd.—Young 73, 88; Nam Tamai Valley, Burma-Tibet frontier—Ward 9151.
V. gigantea (Bory) Dickason. Stilwell Rd., Burma border—Young. First record for Burma.
V. pyxidifera (L.) Copel. Tenasserim—Parish.
V. radicans (Sw.) Copel. Mooleyit, Tavoy—Beddome; Sin Lum Kaba-Loiji Rd., 35th Mile—284.

DICKSONIACEAE

72. *Cibotium* Kaulfuss

- C. barometz* (L.) J. Sm. Near Mt. Nwalabo, Tavoy—Parish; Madremacan, Mergui—Parish;

Namkham—37; Mogok—150; Loiye ford; Kengtung—9153; Pangyang, Manglun State—9793; Mongyai, N. S. S.—9628. One of the commonest ferns in Nanglun and Kentung States.

DENNSTAEDTIACEAE Ching
(Ching 1940b)

73. *Dennstaedtia* Bernhardt

D. scabra Wall. Namkham—251; Sin Lum Kaba—360, 392.

74. *Microlepia* Presl

M. hookeriana (Wall.) Presl. Stilwell Rd.—Young 201. First record for Burma.

M. trapeziformis (Roxb.) Kuhn. Kengtung State—Rock 2230; Thandaung—49; Stilwell Rd.—Young 150.

M. trichocarpa Ching ined. Sin Lum Kaba—337; Pangwai, Kengtung State—9416. First records for Burma.

M. firma Mett. Mogok—124, 130; Sin Lum Kaba—282; Haka, Chin Hills—7422. First records for Burma.

M. hirta (Kaulf.) Presl. Kengtung State—Rock 2088; Mogok—126, 127, 127A, 132; Sin Lum Kaba—346; Mt. Nwalabo, Tavoy—8223.

M. rhomboidea Presl. Stilwell Rd.—Young 201. First record for Burma.

M. pyramidata (Wall.) Lacaita. Stilwell Rd.—Young 75, 202, 203. First records for Burma.

M. marginata (Houtt.) C. Chr. var. *calvescens* (Hk.) C. Chr. Kengtung State—2180.

M. platyphylla (Don) J. Sm. Kengtung State—Rock 2232; Loimwe, Kengtung—509, 9113; Lamtok, Haka, Chin Hills—7680; Taungteik—7238.

M. kurzii (Cl.) Bedd. Kengtung State—Rock 2083; Mogok-Momeik Rd.—153.

LINDSAYACEAE Ching

75. *Lindsaya* Dryander

L. cultrata (Willd.) Sw. Madremacan, Mergui—Parish.

L. malabaricum (Bedd.) Bak. Oktada, Martaban Hills, Kalama Range—Rock 750; Stilwell Rd.—Young 204.

L. orbiculata (Lam.) Mett. Stilwell Rd.—Young. First record for Burma.

L. lancea (L.) Bedd. Rangoon (cultivated)—456.

76. *Schizoloma* Guadichaud

S. ensifolia (Sw.) J. Sm. Moulmein—Parish; 575; Ka-lein-aun, Tavoy Distt.—8020; Kyaukme Taung, Tavoy Distt.—8007.

77. *Stenoloma* Fée

S. chusanum (L.) Ching. Kengtung State—Rock 2078; Loimwe, Kengtung State—9105; Pangyang, Manglun State—8074; Namkham—38, 221, 225, 263; Sin Lum Kaba—278, 279, 285; Thandaung—6721; Stilwell Rd.—Young 206.

DAVALLIACEAE Gaudichaud
(Ching 1940b)

78. *Davallodes* Copeland

D. membranulosum (Wall.) Copel. Loimwe, Kengtung State—521. First record for Burma.

79. *Acrophorus* Presl

A. stipillatus (Wall.) Moore. Between Sadon and Yunnan border—Rock 7392; Haka, Chin Hills—7506.

80. *Leucostegia* Presl

L. immersa (Wall.) Presl. Tenasserim Distt.—Parish; Thandaung—57; Mt. Popa—564; Taunggyi—8683; Loimwe, Kengtung—518.

- L. faberiana* (C. Chr.) Ching. Between Sadon and Yunnan border—Rock 7418.
L. hymenophylla (Parish) Bedd. Moulmein—Parish.
L. pulchra (Don) J. Sm. Moulmein—Parish; Mt. Popa—539, 540.
L. dareiformis (Hk.) Bedd. Dauna Taung—Parish; Moulmein—Clarke.

81. *Humata* Cavanilles

- H. assamica* (Bedd.) C. Chr. Stilwell Rd.—Young 207. First record for Burma.
H. alpina (Bl.) Moore. Mergui and southwards—Parish; road between Amherst and Tavoy—San Tun Yin.
H. griffithiana (Hk.) C. Chr. Loiye ford, Burma-Yunnan border—409; Loimwe, Kengtung State—9165; Stilwell Rd.—Young 65. First records for Burma.

82. *Davallia* Smith

- D. pectinata* (Sm.) Desv. Mergui southwards—Parish.
D. bullata Wall. Mergui—Parish; Mogok—142; Loimwe, Kengtung—522.
D. lorrainei Hance. Kalaw (Pipe line)—26. First record for Burma.
D. denticulata (Burm.) Mett. Mergui—Parish; Tavoy—8051; Rangoon, Bird Island—192; Syriam—461; 461A; Maubin Distt.—8057.
D. solida (Forst.) Sw. Merwui—Parish.
D. solida var. *fijiensis* Diels. Rangoon (cultivated)—460.
D. speciosa Mett. Moulmein—Ind. Fil.

83. *Nephrolepis* Schott

- N. acutifolia* (Desv.) Christ. Tavoy—Parish.
N. biserrata (Sw.) Schott. Rangoon (cultivated)—158.
N. cordifolia (L.) Presl. Moulmein—Parish; Kyaukme Taung, Tavoy—8027; Toungoo—544; Mt. Popa—504, 543; Syriam—463; Nattaung, Karenni—9437; Taunggyi—8122A; Pangwai, Kengtung—7879, 9127; Stilwell Rd.—Young; Nam Tamai, Upper Burma—Ward 9179.
N. duffii Moore. Rangoon (cultivated)—156.
N. falcata (Cav.) C. Chr. Martaban—Parish; Kyaukme Taung, Tavoy—8237.

DIDYMOCHLAENACEAE Ching (Ching 1940b)

84. *Didymochlaena* Desvaux

- D. truncatula* (Sw.) J. Sm. Ta-ok, in damp hollows—Parish.

PLAGIOGYRIACEAE Bower

85. *Plagiogyria* (Kunze) Mettenius

- P. adnata* (Blume) Bedd. Nattoung—Beddome.

MONACHOSORACEAE Ching (Ching 1940b)

86. *Monachosorum* Kunze

- M. subdigitatum* (Bl.) Kuhn. Between Sadon and Yunnan border—Rock 7404.

HYPOLEPIDACEAE Ching (Ching 1940b)

87. *Hypolepis* Bernhardt

- H. punctata* (Thbg.) Mett. Kengtung State—Rock 2337; Loimwe—9114; Namkham—261.

SINOPTERIDACEAE Koidzuma
(Ching 1940b)

TRIBE 1. CRYPTOGRAMMEAE

88. *Cryptogramma* R. Brown

C. brunoniana Wall. Adung Valley, 12,000 ft., Upper Burma—Ward 9919. First record for Burma.

TRIBE 2. CHEILANTHEAE

89. *Cheilanthes* Swartz

C. fragilis Hk. Moulmein (on limestone rocks)—Parish.

C. mysurensis Wall. Thandaung—6727; Manipur River below Falam—7552. First records from Burma.

C. belangeri (Bory) C. Chr. Moulmein—Parish; —568; Tavoy—7979; Rangoon—166, 469, 586; Twante—8045.

C. tenuifolia (Burm.) Sw. Tavoy—7987; Moulmein—569; Rangoon—586A; White Crow Lake, below Taunggyi—8183. First records from Burma.

C. argentia (Gmel.) Kunze. Mergui—Clarke; Zwakabin—Parish.

C. farinosa (Forsk.) Kl. sens lat. Zwakabin and Beloogewn (sea level)—Parish; Tavoy, 2500 ft.—8028; Mt. Popa—554, 555, 6603; Taunggyi—36, 621; Wetwun—634; Sin Lum Kaba—265; Taingteik, Chin Hills—7553, 7554; Falam—7567.

C. farinosa var. *chrysophylla* Hk. Mergui—Clarke; Zwakabin—Parish.

C. farinosa forma *dalhousiae*. Mt. Popa—6603A; Mogok—119; Maymyo Herb.—581.

C. farinosa var. nov. Goteik Gorge—215. First record for Burma.

C. farinosa var. nov. Thandaung—56. First record for Burma.

C. rufa Don. Mergui—Clarke; Zwakabin—Parish; Mt. Popa—6611; Taunggyi—36, 183.

C. sp. nov. (near *subrufa* Bak.). Manipur River below Falam, Chin Hills—7551. First record for Burma.

C. duclouxii (Christ) Ching. Kalaw—22; Taunggyi—182. First records for Burma.

90. *Doryopteris* J. Sm.

D. ludens (Wall.) J. Sm. Moulmein—Parish; Maymyo—105, Goteik Gorge—201; Mt. Popa—476, 6651; Webula, Chin Hills—7762.

TRIBE 3. ONYCHIEAE

91. *Onychium* Kaulfuss

O. japonicum (Thbg.) Kunze. Ava—Hope.

O. lucidum (Don) Spreng. Loinwe, Kengtung—9149; Sin Lum Kaba—275, 327, 378; Falam, Chin Hills—7240; Haka—7707. First records for Burma.

O. siliculosum (Desv.) C. Chr. Amherst—Clarke; Kyain, Amherst Distt.—6863; Toungoo—Maymyo Herb.; Pyinmana—7113; Mogok—Momeik Rd.—118; Myitkyina; Kengtung State—Rock 2073.

PTERIDACEAE Ching
(Ching 1940b)

TRIBE 1. LONCHITIDEAE

92. *Pteridium* Gleditsch

P. aquilinum (L.) Kuhn. Mooleyit, foot of Mt. Nwalabo—Parish; Tenasserim—Hope; Mt. Victoria, Chin Hills—8596; Haka—7670; Mogok—134, 136; Kutkai—218; N'Bapa—262; Molahein Mt., Lawksawk State—8735; Loinwe, Kengtung—9147.

P. aquilinum var. *esculentum* Forst. Moulmein southward—Clarke; Maymyo—33; Taunggyi—472; 9006; Namkham—235; Mogok—134.

93. *Histiopteris* J. Smith

H. incisa (Thbg.) J. Sm. Kengtung Rd. at Salween River—9281. First record for Burma.

TRIBE 2. PTERIDEAE

94. *Pteris* Linn.

- P. vittata* L. Common everywhere—Parish; Kyain, Amherst Distt.—6899; Pyinmana—7112; Kalaw—21; Taunggyi—35, 184, 9012, 9298; Takaw, Kengtung State—9292; Maymyo—424; Mogok—109; Momeik State—147; Kalemmyo—7209; Tiddim, Chin Hills—635.
- P. cretica* L. Amherst Distt.—Parish; Kalaw—5; Taunggyi—477; Loimwe, Kengtung—537; 9242; Maymyo—32; Sin Lum Kaba—372; Haka, Chin Hills—7546.
- P. cretica* var., or sp. nov. Sin Lum Kaba—353. First record for Burma.
- P. heteromorpha* Fée. Burma—Parish.
- P. dactylina* Hk. Tang-tung, Upper Burma-Vernay-Cutting Exped. 325 (Ward).
- P. ensiformis* Burm. Kengtung State—Rock 2031; Rangoon (cultivated)—556; Stilwell Rd.—Young.
- P. griffithii* Hk. Tamu, Upper Burma-Vernay-Cutting Exped. 10 (Ward).
- P. pellucida* Presl. Kengtung State—Rock 2246; Kyauktalon, Moulmein Distt.—6833; Stilwell Rd.—Young 42.
- P. nervosa* Wall. Amherst—Parish; Rangoon—636; Syriam—462; Pyinmana—7119; Mt. Popa—550, 551, 562; Sin Lum Kaba—348; Mogok-Momeik Rd.—111.
- P. esquirolii* Christ. Kengtung State—Rock 2188.
- P. semipinnata* L. Mergui, on the Tenasserim River—Parish; Stilwell Rd.—Young.
- P. decrescens* Christ. Goteik Gorge—206. First record for Burma.
- P. grevilleana* Wall. Stilwell Rd.—Young 59. First record for Burma.
- P. khasyana* (Cl.) Ching. Haka, Chin Hills—7311. First record for Burma.
- P. fauriei* Hieron. Pyinmana—7115; Taunggyi—473, 476; Namkham—N'Bapa—244; Mogok—114. First records for Burma.
- P. fauriei* var. *rigida* Hieron. Mogok—113; Kalemmyo-Webula—7210; Haka—7571. First records for Burma.
- P. argyraea* Moore. Tenasserim Distt.—Parish; Kyaukme Taung, Tavoy—8235; Sin Lum Kaba—268; Mogok—101.
- P. aspericaulis* Wall. Zwakabin, Moulmein—7015; Bantai, Kengtung—9251; Stilwell Rd.—Young; Adung Valley, Upper Burma—Cutting Sikkim Exped. 9248 (Ward). First records for Burma.
- P. excelsa* Gaud. Burma—Parish.
- P. longipinnula* Wall. Burma—Ind. Fil.
- P. longipinnula* var. *hirtula* C. Chr. Valley of the Meh Len, Kengtung—Rock 2133 (type).
- P. biaurita* L. Moulmein and elsewhere in Tenasserim Distt.—Parish; Nwalabo, Tavoy—8211, 8019; Taungwine, Moulmein—6845; Kyauktalon, Moulmein—6838; Pyinmana—7124; Thandaung—61; Namkham—24, 227; N'Bapa—271; Mogok—637; Loimwe, Kengtung—524, 529.
- P. linearis* Poir. Kalaw—24A; Loimwe, Kengtung—9108. First records for Burma.
- P. longipes* Don. Tenasserim Distt.—Parish; Pegu—Clarke; Kengtung State—Rock 2179; Sin Lum Kaba—328; Mogok—121; Haka, Chin Hills—7272.
- P. wallichiana* Ag. Sin Lum Kaba—331. First record for Burma.
- P. wallichiana* var. *austro-siniea* Ching. Loimwe, Kengtung—9112. First record for Burma.

ADIANTACEAE Presl
(Ching 1940b)95. *Adiantum* Linn.

- A. parishii* Hk. On top of limestone rock called Zwakabin, Moulmein—Parish; —7041.
- A. philippense* L. Everywhere on the plains—Parish; Kyaukme Taung, Tavoy—8026, 7992; Moulmein—574; Rangoon—10, 160, 470; Thandaung—48; Mt. Popa—549; Taunggyi—475.
- A. soboliferum* Wall. Anisakan Gorge, Maymyo—429. First record for Burma.

- A. edgeworthii* Hk. Fort Stedman, Inle Lake, S. S. S.—Hope; Taunggyi—474; Kalaw—25; Loimwe, Kengtung—510; N'Bapa—309; Sin Lum Kaba—306; Taungteik, Chin Hills—7246, 7565A.
- A. caudatum* L. Kungtung State—Rock 2329; Kengtung—9191; Taunggyi—9014, 9387; Mt. Popa—552, 553, 6607; Wetwun—63; Goteik Gorge—203; Mogok—146; Taungteik, Chin Hills—7241, 7246, 7565.
- A. capillus-veneris* L. Anisakan Gorge—416; Goteik Gorge—213; Kutkai—216; Kalemio-Webula—7760; Yetagone, Chin Hills—7335; Taungteik, Chin Hills—7241; Ruavan, Haka, Chin Hills—7666.
- A. cuneatum* Langsd. & Fisch. Namkham (cultivated)—220.
- A. flabellulatum* L. Mong Yang, Kengtung State—9795; Namhka River, Manglun State—9794. First records for Burma.
- A. trapeziforme* L. Rangoon (cultivated)—157.

GYMNOGRAMMACEAE Ching
(Ching 1940b)

TRIBE 1. GYMNOGRAMMEAE

96. *Taenitis* Willd.

- T. blechnoides* (Willd.) Sw. Amherst—Parish; Moulmein—Parish; Tenasserim—Beddome.

TRIBE 2. GYMNOPTERIDEAE

97. *Congiogramme* Fée

- C. fraxinea* (Don) Diels. Tenasserim—Parish; Chin Hills—Dickason.
- C. petelotii* Tardieu-Blot. Taunggyi—9382; Sin Lum Kaba—344. First records from Burma.

98. *Pityrogramma* Link

- P. calomelanos* (L.) Link. Tavoy—7976; Kyain, Amherst Distt.—6873; Rangoon—189, 585. First records for Burma.

99. *Hemionitis* Linn.

- H. arifolia* (Burm.) Moore. Tenasserim Distt.—Parish; Rangoon—159, 6572; Insein—8157.

ACROSTICHACEAE Presl emend.
(Ching 1940b)

100. *Acrostichum* Linn.

- A. aureum* L. Amherst—Parish; Rangoon (cultivated)—37.

CERATOPTERIDACEAE C. Chr.
(Ching 1940b)

101. *Ceratopteris* Brongniart

- C. thalictroides* (L.) Brongn. Moulmein—Parish; Kyaikto—6828; Rangoon—126; Myaungmya—6930.

MARSILEACEAE

102. *Marsilea* Linn.

- M. brachycarpa* A. Br. Pegu—Ind. Fil.; Pyinmana—542.

SALVINIACEAE

103. *Salvinia* (Micheli) Guettard

- S. cucullata* Roxb. Bhamo—4081. First record for Burma.

104. *Azolla* Lamarck

- A. pinnata* R. Br. Rangoon—Dickason. First record for Burma.

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A NEW SPECIES OF APLASTUS FROM IDAHO (COLEOPTERA: PLASTOCERIDAE)

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***Aplastus acutus* n. sp.**

Male.—Narrow, elongate; moderately shining, light brown above and beneath; short, recumbent pubescence on both surfaces.

Head concave; surface coarsely, densely punctured; eyes moderately prominent; antennae extending beyond middle of elytra, scape short, stout, second segment slightly shorter than third, fourth segment twice as long as second and third together, fifth as long as fourth, sixth slightly longer than fifth, seventh, eighth, ninth and tenth same length as sixth, eleventh segment longest, fourth segment to tenth inclusive somewhat serrate.

Pronotum wider than long, widest at base; anterior margin lobed; basal margin sinuate; lateral margin sinuate, strongly divergent at hind angles; disk convex in middle, flattened along sides giving side margin a sharp carinate edge for its entire length, hind angle with fine carina parallel to lateral margin; surface densely punctured in middle, punctures slightly finer than on head, punctures finer and confluent at sides, obsolete at base. Scutellum small, oval.

Elytra wider than pronotum, elongate; sides subparallel, broadly rounded to suture at apex; surface with striae prominent at base and apex only, rest of elytra indistinctly striate; interspaces densely minutely punctate.

Beneath, prosternum carinate at middle with sutural carina on each side, prosternal process somewhat sulcate; surface coarsely, densely punctured. Abdomen shining, densely, finely punctate. All of tarsi longer than tibiae.

Length 17.5 mm.; width 4.4 mm.

Described from specimens collected by Otto Huellemann at Wallace, Idaho, April 14, 1940. The writer is indebted to Dr. H. F. Strohecker for the privilege of retaining holotype and paratypes; paratypes in the Strohecker collection.

The narrow elongate form, with long antennae and sharp lateral margins of pronotum will distinguish this species from closely related forms.

¹Contribution from Department of Zoology and Entomology.

HIGH MUTANT GENE FREQUENCIES IN A POPULATION OF *DROSOPHILA IMMIGRANS*

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The biology of *Drosophila immigrans* with particular reference to the genetic structure of several populations from widely separated points in the U. S. A. formed the subject of an earlier report (Spencer 1940). It is the purpose of this communication to present data on the genetic analysis of a Western Pennsylvania population of this species in which two mutant genes were present in high frequencies. The analysis also serves as a basis for a discussion of the method of inbreeding by F_1 pair matings as a means of studying the genetic structure of *Drosophila* populations in regard to the recessive visible mutations carried in heterozygous form in wild flies.

THE POPULATION SAMPLE

On September 9th, 1944, three open traps consisting of large tin cans containing over-ripe tomatoes as bait were set in an open woodland near a stream within the environs of New Wilmington, Pennsylvania, a village a few miles from the Ohio-Pennsylvania border and located in Lawrence County. On the morning of September 11th flies from these traps were collected. The catch included many flies of the species, *Drosophila immigrans*.

As pointed out in the earlier report this species, which is tropical or sub-tropical in origin, is a highly successful introduced form throughout the U. S. A. It is more tolerant of low temperatures than *Drosophila hydei*, *melanogaster* and *simulans*, but is probably killed off outdoors in the latitude where the collection was made during severe winters. The peak populations of *D. immigrans* are found in the northeastern part of the U. S. A. in the autumn, at which time small over-wintering foci have bred up to a maximum, feeding on rotting tomatoes and other vegetables, windfall fruit and garbage. The species may be taken in woodland areas at considerable distances from human habitations during the autumn but certainly larger populations are found in gardens and orchards than in the woods.

In the village where the sample was collected *D. immigrans* was observed in great abundance in tomato patches and on windfall fruit. It seems likely that the flies taken were recent migrants from surrounding gardens and orchards. The abundance of the autumn population was not necessarily correlated with the size of the over-wintering focus from which it came, but rather with favorable conditions of temperature, moisture and food supply during the summer and particularly in late summer and early autumn. In some years and areas *D. immigrans* may be scarce even in autumn and it has been the author's experience from many collecting records that the distribution of the species from year to year and place to place is much spottier than that of *D. melanogaster*.

THE F_1 GENERATION

Fifty-six pair matings of flies from the collection were made up in three-fourths ounce cream bottles containing the usual cornmeal, molasses, agar medium heavily enriched with brewer's yeast. To supply larvae with optimum conditions for feeding and pupating a modification of the method described by Spencer (1943) was used. After six days the parent flies were removed from the creamers and one-third of a double sheet of kleenex paper, soaked in a suspension of baker's yeast in water, was added to each creamer. Larvae burrow readily through the paper, find an abundant yeast supply for feeding, and an optimum place for pupa-

tion at the surface of the mat of paper. *D. immigrans* is a fly at least three times the size of *D. melanogaster*. With the technique used, in 24 cultures chosen at random from the total there emerged 1659 ♂♂ and 1632 ♀♀, an average of 133 flies per creamer. Furthermore, these flies were of uniform and normal size, and showed no evidence of overcrowding in the larval stage. The method of culture is recorded as it seems important in population studies to provide optimum culture conditions in small containers which are easily handled and occupy a minimum of space.

Out of the 56 pair matings 55 produced offspring. The flies from 24 of these cultures were carefully examined under the binocular microscope for visible abnormalities and all of these tabulated. In 20 of the 24 cultures one or more of the flies showed small extra sections of wing-vein near the distal end of the second longitudinal vein. 73 ♂♂ out of 1659 examined and 89 ♀♀ out of 1632 showed this character. In 4 of the cultures the character did not appear in the F₁. In 6 to 8 F₁ pair matings made up from each of these 4 cultures the character failed to appear in the F₂ flies from two of these cultures but did show in a few F₂ flies from the other two. This character has been found repeatedly in other populations of *D. immigrans*, and several more extreme net-venation mutants have been recov-

TABLE I

DORSO-CENTRAL BRISTLE COUNTS ON OFFSPRING OF 24 PAIR MATINGS OF WILD *Drosophila immigrans* FROM NEW WILMINGTON, PA.

Total males, 1,659; total females, 1,632. An equal or greater asymmetry in extra bristles would occur by chance less than once in 100 times.

	EXTRA DORSO-CENTRALS				
	Left	Right	Both	Total Left	Total Right
Males	81	56	36	117	92
Females	185	138	111	296	249
Total	266	194	147	413	341

ered. It seems evident that extra-venation is a species-specific variant in *D. immigrans*. Wild flies of the species frequently show slight extra-venation and even more of them carry genetic factors capable of forming net-veins when made homozygous or acted on by modifiers.

An even more common variant among F₁ flies was the presence of extra dorso-central bristles. 23 of the 24 F₁ cultures showed this character, but in very different proportions. Table I gives a summary of the incidence of the character among the F₁ flies from the 24 cultures. The character appears more frequently and is more strongly expressed in females. Among the flies examined the character showed a definite asymmetry, appearing on the left side significantly more often than on the right. Tests and counts in later generations were not made and no explanation of this peculiar asymmetry was found. Like "extra-veins" this character is often met with in *D. immigrans* populations. While extra dorso-central bristles are not uncommon among wild flies of certain other species of *Drosophila*, for example *D. melanogaster* (see Dubinin, Romashov, Heptner and Demidova 1937), they are even more frequent in *D. immigrans*. It is clear that "extra dorso-centrals" has an inherited basis, and several loci may be involved. However, it is possible to find strains of this species in which the character is virtually absent.

Both "extra-veins" and "extra dorso-centrals" would seem to be species-specific variants in *D. immigrans*, highly variable in expression, found in many populations and in large numbers of flies, and probably subject to the action of genetic modifiers. Populations of this species not containing these variants are apparently more rare than those which carry them.

Among the F_1 flies of pair mating (26) there appeared many individuals showing stubble bristles. As all P_1 flies had been examined when pair matings of them were made and none had shown this character distinctly it seemed likely that both of the parents of culture (26) had been heterozygous for "stubble." This would indicate a high frequency of the stubble gene in the population, which was subsequently proved by further analysis.

THE F_2 GENERATION

From the offspring of each of the 55 P_1 pairs of flies either 7 or 8 F_1 pair matings were made up, using the same culturing technique as described above. Where one of a pair of flies mated together carries a recessive visible gene in heterozygous form half of the F_1 offspring should carry this visible gene but none should show the character. The mating may be represented as $VV \times Vv$, where (v) is the gene for the recessive visible and (V) its dominant allele. The offspring will be VV and Vv in approximately equal numbers. The chance then of an F_1 pair mating being of the favorable type, $Vv \times Vv$, to produce some (vv) flies showing the visible phenotype in the F_2 will be $.5 \times .5 = .25$. The chance of a pair mating not being favorable will therefore be $1 - .25 = .75$. When two F_1 pair matings are made up the chance of neither of them showing the character in the F_2 flies will be $.75^2$ and the chance of at least one of them showing it will be $1 - .75^2 = .437$. The more F_1 pair matings made up the more chance there will be of recovering the visible character among the F_2 offspring of at least one of them.

Table II gives the results of the inbreeding test. Only the first 7 F_2 cultures are recorded even where 8 were reared. Of the 55 P_1 matings only those from which visible mutations were recovered are listed in the first vertical column to the left. The first F_1 matings form the second vertical column, the second F_1 matings the third vertical column, etc. Whenever a mutant was recovered from an F_1 mating it is recorded in the table.

The total number of mutants recovered in each vertical column is found at the bottom of the table. Some investigators have held that the subjective error involved in recovering visibles from a population is so great that data on visibles will be very inaccurate. Tables such as the one shown make possible an objective test of this error. Since the same mutant will often turn up repeatedly in several of the F_2 cultures, if the mutant is found in one of the early pair mating cultures examined it will not likely be missed in later ones where it is present. However, if the investigator is overlooking mutants in the early cultures examined he may still see them in the later cultures. Such errors would then tend to give more mutants recovered in the last cultures examined than in the first ones. Since the summary at the bottom of Table II indicates as many mutants recovered from the first three vertical columns as from the last three this error was not present. It should be remembered that 25% of the flies in a given culture are on Mendelian expectation homozygous for the mutant when both parents are heterozygotes. Even where mutant types have lowered viability or incomplete penetrance several to many flies out of the 100 or more flies in the culture will show the character. It is of course true that some mutants will have such a low penetrance and/or viability that they may be missed. Others will require special environmental or genetic tools for their demonstration. Obviously the mutants recovered represent only a fraction of the total genetic changes in the population. But for comparative purposes there is a large class of visibles which may be dealt with objectively with relatively

TABLE II

ANALYSIS OF 55 P₁ PAIRS OF *D. immigrans* FROM NEW WILMINGTON, PA.,
BY 7 F₁ PAIR MATINGS EACH.

Mutants appearing in F₂ cultures shown.

Only numbered P₁ pairs from which mutants were recovered tabulated.

P ₁	F ₁ -1	F ₁ -2	F ₁ -3	F ₁ -4	F ₁ -5	F ₁ -6	F ₁ -7
2	—	—	—	brick	—	—	—
4	—	—	cveinless	—	—	brick	—
5	minute	—	stubble	—	minute	—	—
6	—	—	—	stubble	—	—	stubble
9	—	brick	—	—	—	—	—
15	—	dubonnet	—	—	stubble	—	—
17	—	—	brick	—	brick	—	—
18	—	—	stubble	stubble	—	—	stubble
19	brick	brick	—	—	—	—	—
21	—	—	—	—	—	stubble	—
22	—	stubble	brick	stubble	—	—	—
24	—	—	—	stubble	stubble	—	—
(26)	stubble	—	stubble	(stubble)	stubble	—	—
28	—	—	—	—	sepia-spineless	—	—
29	—	brick	—	—	—	—	—
30	stubble	stubble	—	—	—	—	—
32	broken	stubble	broken stubble	broken	—	broken	purple-net-short
33	—	—	—	—	stubble	stubble	—
34	—	—	tiny	—	—	tiny	tiny
35	—	—	—	—	—	—	stubble
36	—	dubonnet	—	—	—	dubonnet	—
38	—	—	—	—	brick	—	—
40	stubble	—	—	—	stubble	—	stubble
42	double	—	—	double	—	double	—
43	—	—	stubble	—	stubble	—	stubble
46	2-brist.	2-brist. stubble short-5	—	stubble	2-brist. short-5	short-5	short-5
47	—	stubble	—	—	—	stubble	—
48	—	—	small	—	—	—	—
51	stubble	—	—	purplish-thin-sing.	—	stubble	stubble
52	—	stubble	stubble	—	—	—	—
Total	9	13	12	10	12	10	9

NOTE: Both parents of P₁ (26) were heterozygous for stubble. Both parents of F₁ 26-4 were homozygous stubble.

small error under good culture conditions and in the hands of a competent observer.

In Table III the percentages of visibles which should be recovered out of the total visibles present in a given sample where one to five F_1 pair matings are reared are given. The table also shows the number of mutants actually observed and those expected in the sample analyzed. It will be seen that 36 mutants were recovered in the first 5 F_1 pair matings from the 55 P_1 pairs. This, as shown by the table, should be 76.3% of all those present. As the observed and expected frequencies for 1-4 pair matings indicate the validity of the method it is possible to estimate that there were about 47 visibles of the kind being studied actually present in the sample. When 7 pair matings are reared 87% of the total number of mutations should be found. Thus 11% or about 5 of the 47 mutations should be recorded for the first time in columns 6 and 7. Actually 4 mutations do appear here for the first time and we may assume that the 7 not found at all were present in the sample. On the average not quite one visible mutant in heterozygous form was carried per pair of flies tested. These data indicate that the total number of visibles of the kind being studied can be accurately estimated for a population sample by the method of rearing one or more F_2 cultures from F_1 pair matings of the wild pairs of flies constituting the sample.

TABLE III

OBSERVED AND EXPECTED NUMBERS OF MUTATIONS RECOVERED BY REARING 1, 2, 3, 4, AND 5 F_1 PAIR MATING CULTURES OF 55 PAIRS OF WILD *Drosophila immigrans*.

(See text for full explanation.)

F_1 PRS.	EXPECTED PER CENT OF MUTATIONS RECOVERED	NOS. OF MUTATIONS RECOVERED	
		Expected	Observed
1	25%	11.8	9
2	43.7%	20.6	19
3	57.8%	27.3	28
4	68.4%	32.2	32
5	76.3%	36.0	36

TABLE IV

A LIST OF THE DIFFERENT MUTATIONS FOUND IN THE NEW WILMINGTON SAMPLE.
ALL AUTOSOMAL RECESSIVES; STUBBLE INCOMPLETE RECESSIVE.

Eye colors	Bristle changes
(1) brick	(6) double
(2) dubonnet	(7) minute
Wing veins	(8) small
(3) broken	(9) stubble
(4) cross-veinless	(10) tiny
(5) short-5	(11) two-bristle
Phenotypic Complexes	
(12) purple eye—net wings—short wings	
(13) purplish eye—thin bristles—singd hairs	
(14) sepia eye—spineless bristles	

DESCRIPTIONS OF MUTATIONS FOUND

A list of the mutations found is given in Table IV. For comparative purposes a short description of each mutation is given below. As most of the stocks were

soon discarded no symbols have been assigned to the mutations. Similarity between any phenotype and that of a mutation previously recorded in this species is mentioned. The reader is referred to Table II and descriptions of mutations in a former publication (Spencer 1940).

EYE COLORS—

(1) Brick. Autosomal recessive. A dark reddish brown eye-color easily distinguished from the vermilion-like wild-type at all ages. Excellent viability. Recovered 8 times.

(2) Dubonnet. Autosomal recessive. A purplish eye-color completely separable from wild-type but only under proper lighting conditions. Good viability; female sterile. Recovered twice.

WING VENATION—

(3) Broken. Autosomal recessive. Breaks in second, third, and fourth longitudinal veins. Wings may be spread. Some hairs removed lateral to dorso-central bristles. Variable expression with normal overlaps.

(4) Cross-veinless. Autosomal recessive. Anterior cross-vein always missing; posterior cross-vein missing or broken. Developmental period lengthened several days at 22 C. Fair viability and fertility.

(5) Short-5. Autosomal recessive. Distal end of fifth longitudinal vein missing. Second longitudinal may be short and posterior cross-vein broken. Variable with normal overlaps.

BRISTLES—

(6) Double. Autosomal recessive. Two or three bristles from one basal ring. Sometimes only one small bristle or none from basal ring. Most often affects anterior scutellars, then posterior scutellars and dorso-centrals. Apparently reduplication and loss are diverse phenotypic manifestations of the spreading of bristle forming material. A similar case is reported in the phenotypic expression of the mutant, engrailed, in *D. hydei* (Spencer 1942).

(7) Minute. Autosomal recessive. Bristles about two-thirds normal length and correspondingly reduced in thickness. Good viability. Less extreme than minute from Camp Rincon, Southern California.

(8) Small. Autosomal recessive. Bristles about three-fourths normal length. Developmental period of flies lengthened.

(9) Stubble. Autosomal, incomplete recessive. All bristles short and heavy as in Stubble of *D. melanogaster* (Bridges and Brehme 1944). Slight effect in heterozygotes. Homozygotes easily separable from heterozygotes. Excellent fertility and viability. Similar to stubby from Woods Hole, Massachusetts and stubby-like from Gatlinburg, Tennessee. Recovered 19 times.

(10) Tiny. Autosomal recessive. Bristles similar to (8) above, but entirely sex-limited to male.

(11) Two-bristle. Autosomal recessive. Anterior dorso-centrals missing. A few normal overlaps.

PHENOTYPIC COMPLEXES—

(12) Purple-net-short. Autosomal recessive. Purple eye; plexus of veins around posterior cross-vein or posterior cross-vein missing; wings short. This complex semi-lethal and sterile.

(13) Purplish-thin-singed. Autosomal recessive. Dark purple eye; short, thin bristles; hairs singed and sparse; legs misshapen. This complex semi-lethal and sterile.

(14) Sepia-spineless. Autosomal recessive. Sepia eye; bristles very small, some missing; flies soon die. This complex semi-lethal and sterile.

GENE FREQUENCY OF "STUBBLE" AND "BRICK"

The most interesting fact discovered in the course of this analysis was the high frequency of the gene, "stubble," in the sample and therefore presumably in the population from which the sample was drawn. "Stubble," a non species-specific character was recovered 17 times in the first 5 F_2 cultures of the P_1 matings. As 76% of the mutants present in the sample are recovered by 5 F_1 pair matings, then "stubble" was present in about 22 of the 110 flies analyzed or in 20% of these flies. As each fly carries two genes at the stubble locus this gives "stubble" a gene frequency of 10% in the sample and presumably in the population. This is a higher frequency for a given gene, either visible or lethal, than any hitherto reported for any population of any species of *Drosophila* yet investigated, excepting of course species-specific characters widespread in all or most populations of a species. Over 50 populations from the species *D. melanogaster*, *pseudoobscura*, *subobscura*, *phalerata*, *transversa*, *hydei*, *robusta*, *immigrans* and perhaps a few others have been studied on as large or a larger scale than the population under consideration.

The variety of structure revealed by these several populations would lead to the prediction that in a population of populations some might be found with specific gene frequencies as high as that reported here. While the samples have often been inadequate to give an accurate picture of low gene frequencies at specific loci they have been sufficiently large to reveal such a high frequency as here found if it had been present.

It becomes of interest to consider the possibilities of population structure, ecology and selection pressure which might account for the present case. One may consider the possibility that heterozygous "stubble," which has a slight phenotypic effect on bristles, actually maintained a selective advantage in the 1944 summer population of *D. immigrans* in the New Wilmington environment. Some might argue that a laboratory experiment could answer this question. This position fails to take into account the fact that it is next to impossible to simulate a natural environment in laboratory culture, particularly when that environment contains many unknown variables. Even in the relatively controlled environment of the greenhouse economic entomologists have often found it extremely difficult to furnish environmental complexes sufficiently similar to transplant successfully a greenhouse pest thriving at one place to a new environment. It is possible that a selective advantage of heterozygous "stubble" was present under the particular summer environment to which the New Wilmington, 1944, population was subjected. An approximate equilibrium of 10% "stubble" to 90% wild-type might conceivably have been reached in this particular environment by early September, 1944. It seems likely that the change in conditions from the warm, relatively dry summer to the cold, wet autumn would upset such an equilibrium before or soon after it became established. The author considers that the postulated selective advantage of "stubble" is a possible explanation of the gene frequency but not a probable one.

It might be argued that the sample represented the immediate offspring of a very few flies one or more of which were heterozygous for "stubble." As the sample was taken in a woodland lot where there were no concentrated food stores it seems unlikely that this explanation is valid. Rather it would seem that the sample represented for the most part migrants from surrounding orchards and gardens. It is quite possible that these sub-populations from which the sample was drawn would have shown large fluctuations in the incidence of "stubble." We may then assume that the surrounding population contained a 10% frequency of "stubble" or that one or more of the sub-populations contained a considerably higher percentage.

Without postulating a selective advantage of heterozygous "stubble" we may

find a valid explanation in the population structure of *D. immigrans* in this latitude. Spring collection records indicate that this species is winter-killed outdoors in this latitude at least in some winters. The population of a village will then pass through a sharp bottle-neck consisting of a relatively few individuals passing the winter in one or a few fruit-cellars or similar environment. Not every home harbors a winter population of *Drosophila* and the chance element in such overwintering is indicated by the species found from winter to winter. In the author's basement a few winters ago a small population of *D. funebris* survived until spring. This was the only species present. This winter a small population of *D. melanogaster* will survive if the housewife doesn't find the can of fruit, the metal top of which has rusted through. No other species is present.

After the overwintering of a few flies in some basement of a village home the bulk of a spring population may well be established from one or a few females which first reach a favorable outdoor breeding ground. The high incidence of "stubble" in this population might well have resulted from the chance concentration of the stubble gene through two or more of these winter bottlenecks. As more populations of *Drosophila* are investigated even higher gene frequencies in individual populations may be discovered. They will probably be found in populations undergoing sharp seasonal reductions.

In this connection the following case is of interest. Some years ago Dr. Harrison Stalker exposed a *Drosophila* trap, consisting of an open half-pint milk bottle containing banana mash, in a woodland park in Wooster, Ohio. The trap was brought into the laboratory after about a week and contained many *Drosophila* larvae. This group of larvae might be considered a small sub-population of *Drosophila*. When reared out the flies were mostly of the species, *D. simulans*, which has a very spotty distribution in this latitude. More remarkable was the fact that a large proportion of the flies showed a visible wing vein character, a conspicuous break in the second longitudinal vein. This turned out to be an autosomal recessive and the incidence of homozygotes indicated that they probably came from a pair of flies both heterozygous for the wing-vein gene. Thus this micro-population probably contained the mutant gene in a frequency of approximately 50%. Conceivably the 100 or more flies from this open trap might have established a local sub-population of *D. simulans* with an extremely high frequency of a specific mutant gene.

Further evidence on the small effective breeding size of the New Wilmington *D. immigrans* population is gained from the incidence of the eye-color gene "brick." This gene was recovered 7 times in the first 5 F_1 matings indicating its presence in the sample about 9 times or a gene frequency of about 4%. While the sample is probably inadequate to establish accurately the frequency of "brick" in the population, yet its repeated recovery is further evidence in favor of the postulated population structure. Another eye-color, "dubonnet," was found twice.

Seven of the "stubble" recurrences were tested for identity by cross-tests and all proved to be identical or indistinguishable alleles. A test of 4 of the "brick" recurrences showed them to be identical. With the distinct phenotypes of "stubble" and "brick" it was thought that the above test was sufficient to establish the allelism of the recurrences found. When genes reach this frequency in a local population they may persist for years. Thus the gene for vermilion eyes, a sex-linked recessive visible in *D. hydei*, attained a frequency of 6.5% in a sub-population of this species in Wooster, Ohio, in September, 1931 (Spencer 1932). This gene persisted in the local populations for at least 6 years.

This *D. immigrans* population represents an extreme variant in the population of *Drosophila* populations thus far investigated in regard to the high frequency of a single mutant gene. It indicates that under certain environmental conditions population structure may be such as to favor the rise to high values of specific gene frequencies. It is conceivable that "stubble" in heterozygous condition also had

a selective value under the particular environment to which the population was subjected. The genetic analysis of the population gave no information on the relative roles of selection, mutation rate, population size and migration. For a theoretical discussion of the roles of these factors the reader is referred to the publications of Dr. Sewall Wright (1931; 1937). Based upon an ecological study of the species in the latitude in which this population was found the author considers that the breeding structure of the population, with sharp seasonal fluctuations in size, was probably the main factor in determining the frequency of the gene, "stubble," in this Western Pennsylvania population of *D. immigrans* in September, 1944.

SUMMARY

A population sample of *Drosophila immigrans* was collected from three traps exposed in a woodland lot in the village of New Wilmington, Western Pennsylvania, in September, 1944.

From 55 pair matings of the wild flies F_1 cultures were reared; 24 of these were examined for variants and showed a high incidence of "extra venation" and "extra dorso-central" bristles, both of which are species-specific characters generally encountered in populations of this species.

"Extra dorso-centrals" was found more often in females and showed a marked asymmetry in both sexes.

In one F_1 culture "stubble" bristles, an autosomal, incomplete recessive appeared in homozygous form in many flies.

Analysis of the sample by 7 F_1 pair matings from each P_1 culture resulted in the recovery of 14 different visibles. Each of these is described.

A study of the data indicates that about 47 visible mutant genes, counting recurrences, were present in the 110 flies constituting the sample.

The gene, "stubble," on the basis of the number of times recovered, is estimated to have had a frequency of about 10% in the population sample.

The gene, "brick," was recovered 7 times and "dubonnet" twice.

As "stubble" showed a slight phenotypic effect in heterozygotes the possibility that it might have had positive selective value is considered.

Extreme reduction in population size resulting in chance fluctuation of gene frequencies is considered the probable explanation of the high incidence of "stubble."

Other cases of high gene frequencies probably due to such seasonal bottlenecks are cited.

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DIFFERENTIAL STAINS OF INSECT TISSUES¹

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In entomological work there is a great need for stains which will pick out specific organs and tissues. This is especially true for the work of gross dissection and the recognition of the boundaries and shape and form of the internal organs. In the dissection of mammals the lungs are pink, the muscles a darker pink, the liver a brownish red, the kidneys a grayish red, the testes yellow, etc. Few anatomists realize the tremendous positive aid such differences of color give the research student. In the insects, nearly all internal organs and tissues are white so that color values in the recognition and differentiation of parts are absent.

This lack of color help has tended to limit studies of the internal anatomy of insects to the larger organs, such as the sexual, digestive, muscular and nervous systems. A review of the literature shows that the heart has seldom been observed even in some elaborate published studies of internal organs. The heart wall is one cell thick! This organ actually disappears in many dissections especially of preserved material.

This review of stains for specific tissues and organs is a first attempt to locate stains which when injected in dilute solution into the live insect color only specific organs against the general white background. This procedure would be classed as intra-vitam staining. It prepares the internal structure for gross dissection.

It was found necessary to develop a technique to include the handling of the subjects as well as the application of the material. One method has been worked out and will be explained along with the results produced by a number of stains in its application. In using a number of different stains it was found possible to determine to some extent whether those so-called "vital stains" from other fields of investigation could be so classified in entomology. In certain cases some were found usable that are not usually considered for viable tissue.

The use of the American cockroach *Periplaneta americana* for the experimental subject was due to its generalized structure and ready availability. For the purposes of a control other forms were used as will be explained.

The writer wishes to express her sincere appreciation for the guidance given by Dr. C. H. Kennedy of the Department of Entomology who, acting as adviser, counseled and encouraged the pursuit of this project. The aid and suggestions given in the obtaining of materials by Dr. G. W. Blaydes of the Department of Botany were also greatly appreciated.

MATERIALS AND METHODS

EXPERIMENTAL ANIMAL.

The basic experimental subject was the American cockroach *Periplaneta americana*. Data were more easily obtained by using the adult form as the strength of solutions used was high and forms younger than six months of age did not survive except in a very small percentage. The sex of the insect did not prove to be a differentiating factor as was shown in a number of cases where the reaction to a stain was found to be identical in both the male and female forms. However, more males were used in the work because of the available supply and the sparing of some females for colony perpetuation.

¹Part of thesis presented for the degree of Master of Science, Department of Zoology and Entomology, The Ohio State University.

EQUIPMENT.

Small size battery jars served as retaining chambers for insects undergoing the tests. Each housed only those subjects containing one of the stains. The jars were marked as to the stain being used as well as the date of injection. From each were taken the subjects that had passed the time interval required, for each observation stage. These were examined, and then the data recorded.

Three materials were used for lessening the activity of the experimental insects during the injection of the staining materials and at the time of the observational dissection. One of these was chloroform, the first used and least satisfactory. Its use was discontinued mainly due to the high mortality rate in the roach population. If the insects were left in the anesthetizing chamber a minute more than the time required to cause the cessation of rapid leg movement, the possibility of recovery was only 50 percent. More successfully used was ether. Complete cessation of movement (external) could be awaited with an expectation of 95 percent recovery. Complete relaxation of the insect being used permitted the injection of the stain and the transfer to the housing jar with an additional few minutes before visible activity was again evident.

When a number of roaches were required at one time or when excessive excitement in the culture prevented the easy removal of desired specimens, carbon dioxide gas was employed. The entire culture was exposed for one minute. After that only some head and leg movements were visible and the desired specimens could be removed and the gas driven off the remainder to permit recovery. The effect lasted one to five minutes and then normal activity was again observed.

For injection, pipettes scaled to deliver 2-3 cc. were first used, but these were abandoned, because the amount of staining material proved to be excessive and the internal organs were often injured as well as the cuticular body covering. A hypodermic needle (1 cc.) using a small needle was the replacement. With this 0.1 cc. injections were made.

Injection of the stain by means of a hypodermic needle proved to be not only the most successful means of application but also the easiest. The point of injection used throughout was at the base of the third abdominal segment on the ventral side, a little off the center of the body. In the attempts to use immature forms under six months the piercing of internal organs proved a serious cause of death.

A binocular microscope was employed to study the internal structures and the observations recorded. The insect was still alive while the dissection and subsequent study were made and it was possible to observe the reactions of the visceral structure (as parts of the digestive system and the heart).

EXPERIMENTAL TECHNIQUE.

The first step after the insect was removed from the stock culture was to apply an anesthetizing agent, preferably ether, until all violent external movement ceased. This was accomplished by placing the animal in a closed jar containing a small piece of cheesecloth saturated with ether. Then after being placed on a small dissecting pan and held steady by the investigator's hand, the hypodermic needle was inserted at the base of the third abdominal segment, and the stain being used was injected.

After the injection was made, the insect was placed in a housing jar properly labeled as to type of stain used and the date. As will be observed, a definite time interval schedule was set up. These were one-half hour, one day, two days, and three days. These periods were used not only as an equalizing measure but also as a test of speed and viability. After retention over the time interval desired, the dissection was made and the gross results obtained.

Before observation began ether was again used; then upon removal to a dissecting pan the legs and wings (if present, on female specimen) were removed. The body was opened by a slit through the center of the ventral side from the

base of the head to the tip of the abdomen. The body was then spread open and pinned so the internal area was entirely exposed.

All the stains used were made up at the percentage of one gram of dry material used to 100 cc. of normal salt solution. This was a fairly high concentration for staining material and may play a definite role in those types upon which it was impossible to obtain data except over a very short time interval. The problem arises in this connection as to what dilution the stains might be carried in order to obtain like results, but this was not determined.

EXPLANATIONS

TERMS.

V-shaped—The heart wing muscles: color extending along tracheae from the heart region in shape of a V with the large end toward the heart.

Fractions—Refer to percentages of total amount or number of particular organ or group of same type of organs affected.

All stains tested are classified under four headings:

1. Outstanding Results.
2. Results Fair.
3. Lack Good Results.
4. Incompletes.

Each stain is taken in order and has under it all organs and tissues that showed results. Those organs and tissues not mentioned were found to be of the normal color and condition. Opposite this listing or following it is the description of the appearance after a definite time interval that was allowed. All the stains are classified in the same intervals of time.

The findings classified under *Incompletes* have been the results of death appearing at the time intervals described. Under repeated testing the mortality rate continued to appear so high, it was found impossible to gain results at the concentration of staining material used.

OUTSTANDING

BLUE DE LYON O.

Two days testing proved best for number of structures shown and variation of color. The gizzard and crop were blue tinged; the heart light blue outlined; malpighian tubules pale blue to lavender; salivary glands very pale blue; and small intestine pale lavender. The thorax muscles were blue near the dorsal side while the fat bodies were blue about the injection point, and the dorsal wall material was blue (pale) for a short distance on either side of the heart. In half an hour the organs shown were the gizzard, caecae, heart outline, tracheae (partially), malpighian tubules, and intestines; in one day were shown the gizzard, heart outline, crop, edges of caecae, salivary glands, thorax muscles and digestive tract; for three days only the caecae and heart outline showed.

ANILINE BLUE.

Here half an hour gave the best results. Scattered portions of the fat bodies were light blue; the thorax muscles grey; the dorsal wall material a dead white. The caecae and tracheae (in the thorax) had faint blue outlines. The gizzard was blue tinged, the heart faintly so; while the salivary glands had a faint grey-blue tinge. After one day less distinction but some color was in a few fat bodies, malpighian tubules, heart outline, while the dorsal wall material and femurs were colorless; two days presented caecae, heart and crop; and the third, the heart and tracheae.

AZUR II.

For structures half hour results are taken. Light lavender fat bodies, lavender outlined heart, and tracheae (color from heart) showed easily. The thorax muscles.

were blue; salivary glands dark blue; caecae (swollen) blue; blue tinge on crop; and greenish blue on malpighian tubules. For color variance one day proved good. Here was easily seen the lower halves of the crop and gizzard, dorsal wall material, fat bodies, salivary glands, heart, and caecae; two days presented caecae, gizzard, intestines, fat bodies, salivary glands, malpighian tubules, and dorsal wall material; in three days was still shown the fat bodies, dorsal wall material, salivary glands, gizzard, and large intestine.

BRILLIANT CRESYL BLUE.

Here two days testing proved best for structures and color. The gizzard, caecae, salivary glands, large intestines were lavender while the malpighian tubules were a mixture of this and yellow. The dorsal wall material was dark blue; the fat bodies bright blue with lavender marks; the heart blue-tinged (not all through thorax); the femurs green; and thorax muscles bluish-green; except for parts mentioned the digestive tract was deep blue. With half an hour the large intestine and most of the other internal structures were colored; with one day the gizzard, caecae, intestine, half the malpighian tubules, crop, fat bodies, dorsal wall material, heart, and salivary glands were designated; likewise on the third day.

TOLUIDIN BLUE.

For structures and color one day timing proved most productive. Lavender was the color of the thorax muscles, salivary glands, while it tinged the crop and the gizzard. The tracheae were blue-tinged near the heart while the heart itself had blue outline varying from pale to dark. The ovaries were light blue and the fat bodies deep blue; the malpighian tubules and caecae green. In half an hour reactions were seen on fat bodies, caecae, salivary glands, gizzard, and heart; in two days thorax muscles, fat bodies about intestines, salivary glands, and dorsal wall material were clear; blue predominated with three days on fat bodies, salivary glands, and heart outline.

TRYPAN BLUE.

With this stain half hour timing showed the most structures and color variance. The salivary glands and ovaries were pale lavender; the caecae blue tinged; the malpighian tubules lavender tinged. After one day the stomach, tracheae, and heart were shown; two days only the heart appeared touched; this was the same on the third day as the second.

ROSE BENGAL.

Three days timing proved most effective for showing the greatest number of structures. The crop and gizzard were deep red; the caecae orange-red; the thorax muscles red streaked. The salivary glands were deep pink while the ovaries were pink. The dorsal wall material was light scarlet, and half of the malpighian tubules and fat bodies were bright scarlet. The heart was deep wine. Two days was best for color variation. Here appeared the crop, gizzard, caecae, heart, dorsal wall material, salivary glands, ovaries, malpighian tubules, part of the fat bodies, and femurs; with half an hour all the insides were colored; one day showed dorsal wall material, malpighian tubules (most), tracheae, and ovaries with some other scattered coloring.

RESULTS FAIR

BIEBRICH SCARLET.

The most results were gained from one day tests. The heart, fat bodies and dorsal wall material were scarlet; the small intestine red; the malpighian tubules bright orange; and the salivary glands bright pink. Half hour testing produces the most color. There showed up the malpighian tubules, digestive tract, salivary glands, thorax muscles, and heart; two days showed malpighian tubules, heart, and

light outlining of the tracheae; three days produced results on dorsal wall material, heart, malpighian tubules, and salivary glands.

GENTIAN VIOLET IMP.

After one day the greatest color variance and results were obtained. Violet predominated, showing in the crop, gizzard, fat bodies, heart, dorsal wall material, small intestine, and caecae. The salivary glands were a deep lavender and half the malpighian tubules were lavender. After half an hour there showed the crop, gizzard, heart outline, salivary glands, malpighian tubules and fat bodies; with two days were traces on crop and some fat bodies; like traces were seen on the third day on salivary glands, fat bodies, gizzard, malpighian tubules, and small intestine.

CONGO RED.

Two days work was the best for structure and color results with this stain. Dark brown flakes were scattered in the body cavity. The fat bodies and dorsal wall material were orange-brown colored; crop and gizzard dark red-brown; the caecae dark red with a dull red coating over the heart; and the salivary glands dull lavender. Half an hour produced results on salivary glands, digestive tract, fat bodies, dorsal wall material, and heart; one day on salivary glands and gizzard, fat bodies, crop, and heart; three days on heart, caecae, malpighian tubules, and salivary glands.

BORDEAUX RED.

With this, one day brought more structures to attention. Pink predominated, being on the salivary glands, crop, gizzard, small intestine, and outer two-thirds of the tracheae. The malpighian tubules were dull red (granular in appearance) as was the heart (near the tracheae). The thorax muscles had a few red streaks. Half hour testing produced more color variance. Here showed up clearly the heart, salivary glands, malpighian tubules, caecae, dorsal wall material, and thorax muscles; two days showed caecae, small intestine, and heart; while three days showed salivary glands, fat bodies, crop, and heart.

SAFRANINE O.

With this stain more structures showed up in a day. The pink of the upper half of the crop, dorsal wall material, heart outline, fat bodies, and gizzard showed as deep pink on the salivary glands and thorax muscles. The small intestine and caecae were bright scarlet; the malpighian tubules bright orange. The color variance was best in two days. The salivary glands, caecae, malpighian tubules, thorax muscles, small intestine, and heart outline were seen; with half an hour was seen the malpighian tubules, crop, thorax muscles, and caecae, salivary glands, dorsal wall material and heart outline; in three days was seen these: small intestine, fat bodies, thorax muscles, salivary glands, and heart outline.

DAHLIA B.

Half hour results showed more structures and color. Two-thirds of the fat bodies, malpighian tubules, and sides of the heart were lavender; gizzard, salivary glands, and lower end of crop violet. In one day could be seen the salivary glands, half the fat bodies, dorsal wall material, and thorax muscles; in two days the anterior half of the fat bodies, heart, caecae, and a few malpighian tubules; in three days salivary glands, fat bodies, caecae and small intestine.

METHYL VIOLET B.

One day proved the optimum timing. The fat bodies, malpighian tubules, and dorsal wall material were colored rose lavender; gizzard and small intestine light violet. The salivary glands were lavender with violet colored "veins," and the heart outline was violet. Half hour results were for salivary glands, crop, gizzard, fat bodies, heart outline, and malpighian tubules; two days for heart outline (in

the thorax), caecae, salivary glands, digestive tract, and fat bodies; three days for large intestine, malpighian tubules, and fat bodies.

LIGHT GREEN S F YELLOWISH.

Half hour results were best on structure and color counts. The ovaries were spotted with pale green; the malpighian tubules brilliant green colored; the gizzard dark green as well as the heart outline; the salivary glands pale blue. The crop, dorsal wall material, and thorax muscles (at base of legs 1 and 2) were green tinged. In one day we find malpighian tubules, heart outline, salivary glands, femurs, gizzard, large and small intestines, and crop; two days find salivary glands, malpighian tubules, heart, crop, thorax muscles and small intestine, tracheae and femurs; three days find heart outline, dorsal wall of heart, half malpighian tubules, large intestine, and thorax muscles.

FAST GREEN F C F

Half hour work produced the greatest number of affected structures. Bright green predominated as shown in the fat bodies tinge, salivary glands, gizzard, intestines, and ovaries. There were traces of green on the crop and malpighian tubules as well as the tinge on the thorax muscles. Half the caecae were green; the heart covered with dark green; and the dorsal wall material had a blue-green tinge. Two days produced more color variation, on salivary glands, femurs, dorsal wall material, crop, gizzard, heart, caecae, tracheal outlines, malpighian tubules, fat bodies, and intestines; one day showed on fat bodies, malpighian tubules, femurs, dorsal wall material, crop, gizzard, intestines, heart, caecae, and stomach; three days on fat bodies, salivary glands, thorax muscles, heart, femurs, base of antennae, caecae, malpighian tubules, crop.

CHLOROZOL BLACK E.

Three days was best for structures. The crop, heart, tracheae (V-shaped outline), and femurs were black; the malpighian tubules, caecae and gizzard were grey with the fat bodies a dark grey as also the salivary glands. The dorsal wall material was almost black while the intestines had a dark lavender tinge. One day work had more color variation. Namely, on crop, heart, caecae, dorsal wall material, fat bodies, malpighian tubules, and salivary glands; half an hour on crop, fat bodies, dorsal wall material, salivary glands, malpighian tubules; two days on fat bodies, crop, malpighian tubules, salivary glands, and heart outline.

AZUR I.

One day proved best for structures and color here. The salivary glands were a true blue, while the thorax muscles were light blue; the malpighian tubules ranged from light blue to deep violet; and both the heart outline and the tracheae were blue tinged. Both the fat bodies and dorsal wall material were pale greenish blue and the caecae and gizzard had faint lavender tinges. After half an hour was seen crop, salivary glands, dorsal wall material, fat bodies, caecae, and ventral nerve cord; after two days was seen fat bodies and dorsal wall material only; but three days had fat bodies, dorsal wall material, salivary glands, and large intestine (posterior end).

COTTON BLUE.

In this stain one day was the best for all results. Loose fluid stain was present in the body cavity. The gizzard was pale blue as was also the salivary glands and the crop (here dark blue streaks present). The fat bodies were blue (at the injection point), as also the caecae and small intestine. The heart was deep blue and the dorsal wall material blue tinged. In half an hour the heart, gizzard, dorsal wall material, and thorax muscles were seen; in two the gizzard, salivary glands, crop, caecae, few malpighian tubules, heart, fat bodies, and intestines were seen; while on three days testing only the heart, salivary glands, caecae and fat bodies.

FUCHSIN BASIC.

The results were brief and best shown after half an hour. The salivary glands, crop, and gizzard (lower half) were light pink; the caecae (half of them) were pink; the malpighian tubules dark pink. In one day was seen half the malpighian tubules, salivary glands, and stomach; in two days only the heart and its outline; then on the third day trials the malpighian tubules, fat bodies (near the digestive tract) and stomach tracheae.

CRYSTAL VIOLET.

Best results for structures and color were gained after one day. Light pink showed in the "veins" of the salivary glands, the stomach, and intestines. The fat bodies near the crop were light lavender, and the heart had a brown outline. Half hour results were on salivary glands, caecae, gizzard, and fat bodies; two days on stomach and dorsal aorta; three days on salivary glands, half the malpighian tubules, caecae, and intestines.

PYRONIN.

More structures were shown after one day. There was a pink tinge on the crop and half the fat bodies. The caecae were pale pink; the dorsal wall material deep pink; a few malpighian tubules deep peach; and the heart deeply outlined in pink (out V-shaped along tracheae). Two days showed color variance, in the dorsal wall material, salivary glands, half the malpighian tubules, stomach, fat bodies, and crop; three days produced fat bodies, dorsal wall material, ovaries, one-third of the malpighian tubules, heart and its outline; in half an hour all the insides (scarlet).

ALDEHYDE GREEN.

Three days was best for structures and variability of color. The female reproductive organs and second and third leg femurs were light green; dark green showed on the fat bodies, dorsal wall material, and heart. Blue-green, light for the thorax muscles and dark for the malpighian tubules showed well. The anterior end of the crop was black. The fat bodies were deteriorated; this condition showed also in one and two-day results. Half hour results were caecae, malpighian tubules, three-fourths of the fat bodies, digestive tract, heart, dorsal wall material, and salivary glands; one day were malpighian tubules, caecae, digestive tract, dorsal wall material, femurs, heart and thorax muscles; two days were digestive tract, malpighian tubules, dorsal wall material, femurs, thorax muscles, and heart.

BORAX CARMINE.

Half hour results indicated the most structures. Scarlet accounted for the dorsal wall material (rosy shade), gizzard, intestines, caecae; fat bodies, salivary glands, and heart went from rose to pink to dull red. Color variance was obtained with three days on heart, posterior end of crop, dorsal wall material and thorax muscles, caecae, and gizzard; one day showed leg muscles, thorax muscles, gizzard to end of the digestive tract, heart; two days showed digestive tract (gizzard on), heart, thorax muscles, and tracheae.

ACID FUCHSIN.

For structures one day was best for timing. The posterior end of the crop and the caecae were wine colored, and the heart and its outline was very deep wine. The dorsal wall material was pink; half the malpighian tubules dull pink. Tinges, pink on thorax muscles and scarlet on the intestines, were also present. Color changes predominated in three days work on thorax muscles, fat bodies, dorsal wall material, heart, intestines, salivary glands; half an hour resulted in fat bodies, heart, salivary glands, dorsal wall material, digestive tract, crop, and two-thirds of the malpighian tubules; two days resulted in fat bodies, digestive tract, dorsal wall material, gizzard and salivary glands.

LACK GOOD RESULTS

ORANGE I.

One day testing proved best for number of structures shown and color variation. The caecae and stomach were reddish; the salivary glands slightly brown; and the thorax muscles red-brown. After half an hour run these showed up, i.e., malpighian tubules, digestive tract, and heart outline; two days, only the heart (tinged); three days, the caecae and traces on dorsal wall material.

AURENTIA.

The best structure and color results were found after one day. Here the caecae and small intestines were reddish; the dorsal wall material and fat bodies had an orange-brown tint; the salivary glands were yellow as was the upper half of the crop (lower half, brown). Half an hour produced fat bodies, dorsal wall material, salivary glands, and caecae; two days produced fat bodies, dorsal wall material, salivary glands, thorax muscles, and caecae; three days produced caecae, small intestine, fat bodies, salivary glands, and heart outline.

THIONIN.

One day results showed more structures and color. The large intestine was purple speckled; the fat bodies were dark blue at the injection point; the tracheae a faint lavender (near the heart). Half an hour had only thorax muscles; two days no results; three days had digestive tract, caecae.

ALIZARINE GREEN G.

Half hour timing was best for both number of structures and variation of color. Light green appeared in the salivary glands, dorsal wall material (traces), and fat bodies (near injection point); the crop was dull green. One day had only malpighian tubules and heart outline; two days only malpighian tubules; three days showed salivary glands, malpighian tubules, and heart outline.

ORANGE G.

More structures and color variance appeared after half an hour. The caecae and stomach were orange; the thorax muscles with an orange-brown tint, and the dorsal wall material brown-tinge. One day lacked color only in fat bodies and malpighian tubules; two days had fat bodies, dorsal wall material, heart, stomach and hind gut; three days had heart, intestines, caecae, and dorsal wall material.

PHLOXINE.

One day's work proved best for coloration and structure showing. Variations of pink dominated; from bright pink of the malpighian tubules and fat bodies (half of them); the pink of the salivary glands and caecae; to the pink outline of the heart. All the viscera were a rosy pink. Three days produced results on malpighian tubules, digestive tract, caecae, fat bodies, and heart.

QUINOLINE YELLOW.

In this stain the half hour group was best for number of structures shown. The fat bodies and dorsal wall material were yellow, while the digestive tract showed an even clearer, bright yellow. The thorax muscles and salivary glands were light orange. For color variations two days was best as on fat bodies, dorsal wall material, caecae, and heart; one day had fat bodies, dorsal wall material, heart, caecae, and digestive tract; three days had fat bodies, dorsal wall material, heart, and digestive tract.

BISMARCK BROWN.

With this stain three days proved the optimum with color and structures. The caecae and small intestine were red-brown and the heart had a red-brown tinge. Along the tracheae the dorsal wall material was brown tinged (in the

abdomen). The fat bodies were brownish pink at the point of injection. Half an hour had tinged fat bodies; two days, fat bodies, dorsal wall material, and tracheae; one day, fat bodies, caecae.

METHYLENE BLUE.

Here one day results were best for number of structures shown. Pale blue showed on the fat bodies and salivary glands while the ovaries had a pale blue tinge as the nerve cord (between the ganglia). The thorax muscles were deep blue as was the heart outline and the caecae tips. The crop showed blue (lower half); the gizzard a purple tinge. Two days showed the most color changes as on intestines, malpighian tubules (few), heart outline, tracheae, salivary glands, caecae, gizzard, and fat bodies; half an hour showed thorax muscles, crop, nerve cord, heart, half the malpighian tubules, ovaries, salivary glands, fat bodies, and gizzard; three days showed crop, gizzard, and fat bodies.

EOSIN Y.

Half hour testing was best for structure number and color. The color went from red of caecae (fluid filled), bright pink malpighian tubules, orange pink salivary glands, salmon pink fat bodies, to orange outlined heart and pink tinged digestive tract and testes. For one and two days all the insides were colored; for three days, only the caecae, dorsal wall material, half the fat bodies, some malpighian tubules.

MAGENTA ROTH.

Extent of coloration and variance showed up in half an hour. The malpighian tubules were scarlet, the fat bodies rosy scarlet, dorsal wall material bright pink, thorax muscles pink; and the caecae were deep wine in color. One day results produced salivary glands, dorsal wall material, and fat bodies; two days, intestines and caecae; the same occurred for three days.

AURAMINE O.

After two days more structures appeared stained. Bright yellow accounted for the crop, malpighian tubules, and female reproductive organs. In the thorax region the heart was deep yellow, while the fat bodies were a creamy yellow and the dorsal wall material slightly yellow tinged. After half an hour all the insides were bright yellow; one day followed suit; three days varied some on caecae, fat bodies, salivary glands, and heart.

RHODAMINE 6G.

Here two days proved best for structure staining and color change. The dorsal wall material and fat bodies were pink and the digestive tract had a slight pink tinge. Salmon accounted for the thorax muscles and ovaries with the malpighian tubules and caecae being lavender. Half hour testing showed fat bodies, malpighian tubules, caecae, dorsal wall material, salivary glands, and digestive tract; one day colored all except tracheae; three days, the intestines, fat bodies, dorsal wall material.

ORANGE II.

After half an hour more structures were shown. The intestines, caecae, malpighian tubules were bright orange; the dorsal wall material, and thorax muscles light orange. The fat bodies and salivary glands had a light orange tinge while the heart had a dark orange outline. The greatest color variation was shown after three days, this on intestines, gizzard, crop, ovaries, and heart; one day showed on malpighian tubules, thorax muscles, femurs, digestive tract, dorsal wall material, and heart; two days showed on heart, malpighian tubules, crop, caecae, and thorax muscles.

WATER BLUE.

Three days presented the best color picture on the greatest number of structures. The caecae and gizzard were blue; the dorsal wall material and femurs a light blue; and thorax muscles were deep blue. The heart had a blue outline (out V-shaped along tracheae). The malpighian tubules were greenish blue. Half an hour showed dorsal wall material, a few malpighian tubules, crop, and caecae; one day showed at least tinges of color on all viscera; two days resulted in heart outline, caecae, gizzard, and ovaries.

INDIGO CARMINE.

More structures were shown after half an hour. Most of the malpighian tubules and the crop were deep blue. The intestines and dorsal wall material were light blue as was the covering of the heart. A few fat bodies were blue tinged. After two days the range of color covered the greatest area, this on half the malpighian tubules, caecae, salivary glands, heart outline and femurs; one day showed one-third of the malpighian tubules, caecae, fat material; heart and malpighian tubules succeeded on three days.

ORCEIN.

In this case one day results proved best for all counts though evidence was meager. The caecae were a very faint pink; the small intestine lavender; and the edges of the heart were yellow tinged. Half an hour showed only the gizzard; two days, the intestines and caecae; three days showed heart outline and few malpighian tubules.

INCOMPLETES**METHYLENE GREEN.**

Half hour testing proved best from the standpoint of number of structures shown and color variation. The salivary glands were pale green; the heart was outlined through the thorax region with green. One day showed the malpighian tubules (half), and ovaries (bleached).

MALACHITE GREEN

Only half hour testing gave results. The salivary glands, caecae and thorax muscles were dark blue; the malpighian tubules and heart were dark green while half the fat bodies were brilliant green. Femurs showed green and tracheae had a narrow blue outline.

PHLOXIN RED.

This also had only half hour data. The dorsal wall material and fat bodies were rosy scarlet; the tracheae had a scarlet tinge; the malpighian tubules were bright red.

NILE BLUE SULPHATE.

Here one day testing proved best for both numbers of structures shown and color variance. The salivary glands, caecae, gizzard, and small intestine were light blue; the dorsal wall material and crop were deep blue; the femurs and malpighian tubules were green. The fat bodies went from deep purple to yellow-green while the heart was violet. Half an hour showed femurs, thorax muscles, digestive tract, fat bodies, dorsal wall material, salivary glands, heart, caecae, and malpighian tubules.

JANUS GREEN B.

Half hour results were best on structure count and color. Deep scarlet showed on the crop and dorsal wall material and combined with blue shades in the fat dies. The malpighian tubules were deep blue as also the caecae; the heart was

more a navy blue; the thorax muscles were blue tinged. Gizzard and salivary glands were lavender. One day results were femurs, thorax muscles, heart, malpighian tubules, dorsal wall material, salivary glands, crop, and fat bodies.

ERYTHROSIN BLUISH.

The half hour work was best in structure and coloration counts. The gizzard was true pink and the ovaries deep pink tinged and a slight pink tinge on the digestive tract. The fat bodies varied from deep to light rose; the salivary glands a deep rose. The caecae were scarlet and the malpighian tubules orange-red. One day presented caecae, heart, thorax muscles, dorsal wall material, malpighian tubules, salivary glands, and fat bodies.

VITAL RED HR.

One day information proved best for structure and color showings. Brilliant scarlet was on fat bodies, gizzard, caecae, malpighian tubules; a duller scarlet for thorax muscles, dorsal wall material, and femurs. The tracheae and salivary glands were pink, while the heart was dark pink with flakes of scarlet lying over it. The intestines had a reddish tinge. Half an hour produced fat bodies, heart, and most of the other viscera.

PO. COCHINEAL.

Half an hour was best with pink tinged small intestine (near the injection point) and dorsal wall material. One day had scattered dull green spots on salivary glands and fat bodies.

RECOMMENDED STAINS FOR PARTICULAR TISSUES

- 1) Heart—Toluidin Blue ($\frac{1}{2}$ hour); Trypan Blue (1, 3 days).
- 2) Tracheae—Fuchsin Basic (3 days); Borax Carmine (2 days).
- 3) Ventral Nerve Cord—Azur I ($\frac{1}{2}$ hour).
- 4) Gizzard—Acid Fuchsin (2 days); Azur II (2 days).
- 5) Caecae—Aldehyde Green (1 day); Acid Fuchsin (1 day).
- 6) Salivary Glands—Brilliant Cresyl Blue ($\frac{1}{2}$ hour, 2 days); Trypan Blue ($\frac{1}{2}$ hour).
- 7) Crop—Bordeaux Red (3 days); Blue de Lyon O (1 day).
- 8) Fat Bodies—Methyl Violet B (3 days); Azur II ($\frac{1}{2}$ hour, 2 days).
- 9) Thorax Muscles—Safranin O (2 days); Toluidin Blue (1, 2 days).
- 10) Malpighian Tubules—Azur II (2 days); Light Green SF Yellowish ($\frac{1}{2}$ hour, 1 day).
- 11) Dorsal Wall Material—Toluidin Blue (2 days); Aniline Blue ($\frac{1}{2}$ hour, 1 day).
- 12) Digestive Tract—Congo Red ($\frac{1}{2}$ hour); Aldehyde Green ($\frac{1}{2}$ hour).
- 13) Hind Gut—Azur II (3 days); Brilliant Cresyl Blue ($\frac{1}{2}$ hour).
- 14) Ovaries—Trypan Blue ($\frac{1}{2}$ hour); Aldehyde Green (3 days).

STAIN MANUFACTURERS

Coleman & Bell Co.....	Norwood, Ohio
Dr. G. Grubler & Co.....	Leipzig
National Aniline & Chemical Co., Inc.....	New York, N. Y.

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MONOSTROMA WITTROCKII IN OHIO¹

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On July 15, 1941, the Ichthyology class from the Franz Theodore Stone Laboratory, Put-in-Bay, Ohio, brought to the Laboratory a large collection of *Monostroma* which they had secured in the Portage River. Although it was immediately identified as a species of this genus it was almost unbelievable that this genus could occur in a freshwater stream so far from its usual marine or brackish water habitat.

During the summer of 1942 the writer visited the area with one of the original collectors but was unsuccessful in finding it although the stream was examined for several hundred yards in either direction.

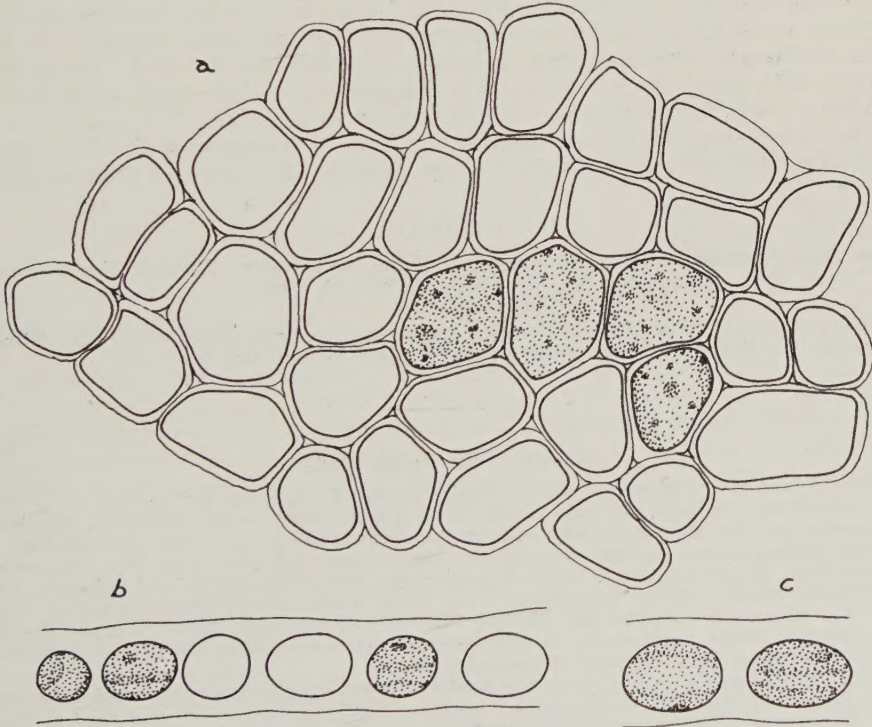


Fig. 1. *Monostroma Wittrockii* Bornet. (a) Cells in face view. (b and c) Cells in section from two parts of the same thallus.

The original discovery was made in that area of the Portage River which lies in Sec. 9, southern Harris Twp., Ottawa County, Ohio. This is about 16.5 miles west of Port Clinton and approximately 5 miles west and a little south of the village of Oak Harbor. The stream at that time had about 50% well defined

¹Paper from the Department of Botany, The Ohio State University, No. 484.

riffles and the remainder pools with little or no current. The bottom was chiefly glacial gravel, boulders and silt. Some field and sewage pollution existed.² The algae, some of which was attached to sedges and unidentified weed stems, formed floating, gelatinous masses along the margin of a silted-bottom pool. The abundance (8 quarts in the collection) as well as the attached thalli attest to the fact that it was well established and that it was not the chance discovery of a few fragmentary scraps discarded accidentally or by design. One can only speculate on the events leading to its introduction into Ohio. Birds may have been responsible, but this seems very unlikely. Another possibility which seems more plausible, is that fragments or reproductive cells were brought in with sea food or with material used in packing such food. The fact that the river flowed through a quantity of trash and kitchen refuse discarded from a home about fifty yards above the area, lends credence to this theory. Its failure to reappear during the summer of 1942 may be due to the scouring of stream bottom and margins by spring floods.

Monostroma Wittrockii Bornet is listed by Taylor (1937) from a salt marsh in southern Massachusetts. In the young form it is attached and saccate. With age it splits more or less into a broad, irregularly lobed blade which is very fragile and breaks loose from its attachment. The blades in the Ohio material reached a length of about 12 cm. and were a pale green color and quite slippery. In parts of the thallus the cells may show a definite grouping into 2 and 4. The cells are angular, with fairly thick walls, and a diameter of 9-18 μ . Cells in section are rounded to oval, 9-12 x 11-15 μ . Thallus about 16-21 μ thick.

The writer expresses his appreciation to Dr. E. N. Transeau of this Department and to Dr. G. W. Prescott, Albion College, Albion, Michigan, for their advice.

CITATION

Taylor Wm. Randolph. 1937. Marine Algae of the Northeastern Coast of North America. Univ. Mich. Studies, Sci. Ser. Vol. 13, pp. 1-427. Pl. 1-60.

²Data pertaining to geographical location and stream conditions supplied by Mr. Milton B. Trautman, The Franz Theodore Stone Laboratory, Put-in-Bay, Ohio.

Insects of the Pacific World

This volume is another in the Pacific World Series. As indicated by the title it covers the insects inhabiting the large and small islands of the Pacific Ocean areas. However, one chapter is devoted to the class Arachnida, with major emphasis on spiders, mites, ticks and scorpions.

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The arrangement of topics is in reverse to that commonly followed in presenting information concerning insects from the classification viewpoint. Each chapter consists of a brief discussion of the characteristics, habits and distribution of major species of each family of the Orders covered.

The book is illustrated by 97 figures and 8 plates. The figures are zinc etchings of adult insects and the plates are half-tones of adult Lepidoptera and Odonata.

The information is authentic and with the style of writing the book should be of considerable interest to the laymen as well as the professional entomologists.—*Ralph H. Davidson.*

Insects of the Pacific World, by C. H. Curran. 317 pages, 105 illustrations. Macmillan Company, New York. 1945. \$3.75.